

Measuring Healthy Beverage Intake and Exploring Opportunities to Improve Beverage  
Consumption

Anna Gustafson Fausnacht, MPH

Dissertation submitted to the faculty of the Virginia Polytechnic Institute and State University in  
partial fulfillment of the requirements for the degree of

Doctor of Philosophy

In

Human Nutrition, Foods, and Exercise

Valisa E. Hedrick, Committee Chair

Brenda M. Davy

Elena L. Serrano

Osman Balci

May 11, 2021

Blacksburg, VA

## ABSTRACT

**Background:** Poor beverage consumption habits pose significant health concerns. Delivering health behavior change interventions via social media is an emerging area of health research and may provide a promising way to minimize barriers such as cost, intervention delivery time, and access. However, there is limited research on online social support health behavior change delivered through Instagram.

**Objectives:** 1) Assess the validity and reproducibility of the updated BEVQ-15, a beverage intake questionnaire; 2) Review the current literature on the availability and effectiveness of mobile phone interventions targeting sugar-sweetened beverage (SSB) consumption; and 3) Use the updated BEVQ-15 to conduct the Healthy Beverage Habits pilot study, which is an online social networking worksite intervention aimed at improving Healthy Beverage Index (HBI) scores.

**Methods:** The Healthy Beverage Habits study was an online randomized controlled pilot trial with an 8-week intervention and a 4-week maintenance period delivered through Instagram. The materials were adapted from the in-person SIPsmartER SSB reduction intervention. Data analysis included RM-ANOVAs to test for differences in beverage intake between the Instagram intervention group and the E-mail control group.

**Results:** For the Healthy Beverage Habits trial, no significant between group over time differences were found. However, the Instagram group demonstrated a significant reduction in total beverage kcal (mean difference $\pm$ SE=-156 $\pm$ 48; p=0.049), and increase in total HBI scores (mean difference $\pm$ SE= 11.9 $\pm$ 2.3; p=0.025) from baseline to the end of the maintenance period. No within group differences were demonstrated for the E-mail control group over the intervention or maintenance period. The study retention rate was 38%, with 39 participants

initially enrolled and 15 participants completing all study visits through maintenance. Results for the validity and reproducibility of the updated BEVQ-15 and a review of the availability and effectiveness of mobile phone interventions targeting SSB consumption are presented.

**Conclusions:** Mobile phone-delivered interventions may be a promising method for improving beverage intake quality. Technologically-based interventions targeting beverage consumption should consider utilizing multiple forms of mobile-phone contact methods. The preliminary findings from the Healthy Beverage Habits trial highlight the need for more rigorous studies that determine which technology and intervention components are most effective for mobile-delivered beverage consumption interventions.

**Keywords:** social networks, behavior change, worksite wellness, digital health intervention, beverage consumption patterns

## **GENERAL AUDIENCE ABSTRACT**

**Background:** Poor beverage consumption habits pose significant health concerns. Delivering health behavior change interventions via social media is an emerging area of health research and may provide a promising way to minimize barriers such as cost, intervention delivery time, and access. However, there is limited research on online social support health behavior change delivered through Instagram.

**Objectives:** 1) Assess the validity and reproducibility of the updated BEVQ-15, a beverage intake questionnaire which estimates habitual average daily intake of 15 beverage categories as well as total sugar-sweetened beverages (SSB) and total beverages. 2) Review the current literature of the availability and effectiveness of mobile phone interventions targeting SSB consumption. 3) Use the updated BEVQ-15 to conduct The Healthy Beverage Habits pilot study, which is an online social networking worksite intervention aimed at improving Healthy Beverage Index (HBI) scores.

**Methods:** The updated BEVQ-15 was assessed for agreement between the BEVQ-15 and dietary recalls. Researchers compared beverage intake between two BEVQ-15 administrations. The Healthy Beverage Habits pilot study was an 8-week intervention with a 4-week maintenance period. Data analysis included testing for differences in beverage intake between the Instagram group and the E-mail group.

**Results:** The updated BEVQ-15 demonstrated moderate agreement between the BEVQ-15 and dietary recalls for total SSB intake and total beverage intake. All beverage variables were significantly correlated. For the systematic review, 11 of the 17 studies (65%) were successful in reducing SSB consumption through mobile phone delivery. The successful studies used multiple types of technology. There were no significant differences for any beverage variable between the

Instagram and E-mail groups over time. However, for within group changes, Instagram significantly reduced total beverage kcals and improved total HBI score, while the E-mail group did not demonstrate any significant changes.

**Conclusions:** Mobile phone-delivered interventions may be a promising method for improving beverage intake quality. Technologically-based interventions targeting beverage consumption should consider utilizing multiple forms of mobile-phone contact methods. The preliminary findings from the Healthy Beverage Habits pilot trial highlight the need for more rigorous studies that determine which technology and intervention components are most effective for mobile-delivered beverage consumption interventions.

## ACKNOWLEDGMENTS

I would like to thank:

My advisor, Dr. Valisa Hedrick, for her undying commitment to my education and for her incredible mentorship. Your guidance and direction have been greatly appreciated. Thank you for taking your time to talk me through so much of the processes necessary to be a successful PhD student and for your constant support and for always making me feel like I am important.

My committee members, Dr. Brenda Davy, Dr. Elena Serrano, Dr. Osman Balci, for their support and guidance throughout this process.

The Virginia Tech HNFE faculty for their mentorship throughout my graduate career.

My fellow graduate students in the Hedrick lab, Emily, Both Erica H's, Molly, Alexa, and Whitney.

My parents, for their everlasting love and support.

And finally, my loving husband Dane. The man who inspired me to pursue a career in academia, as well as convincing me to have two children during the process. Thanks honey!

# Table of Contents

List of Abbreviations ..... x

Chapter 1: Introduction ..... 1

Chapter 2: Review of Literature..... 5

    Introduction and Rationale..... 5

    Beverage Consumption..... 6

*Healthy Beverage Index* ..... 7

*Sugar-Sweetened Beverages* ..... 8

*Water and Fluid Requirements* ..... 9

*Total Beverage Energy* ..... 10

*Measuring HBI Scores* ..... 11

    Social Support Systems..... 12

    Worksite Health Promotion..... 13

    Technological Innovations ..... 15

    Social and Health Support Networks..... 16

*Online Social Support* ..... 17

    Social Media Networks and Health Behavior Change ..... 19

*Weight Loss* ..... 21

    COVID-19 ..... 22

    Theoretical and Conceptual Framework ..... 22

    Health Behavior Message Prompts ..... 23

    Digital Health Interventions in the Workplace ..... 25

    Conclusion ..... 26

Chapter 3: Update of the BEVQ-15, a Beverage Intake Questionnaire for Habitual Beverage Intake for Adults..... 29

    Abstract ..... 29

    Conclusions: This updated version of the BEVQ-15 demonstrated moderate convergent validity and reproducibility for total beverage consumption among well-educated southwest Virginia adults..... 30

    Introduction..... 31

    Methods ..... 32

*Participants and Design* ..... 32

*Development and Scoring of the Updated BEVQ-15* ..... 33

*Data Analysis*..... 36

    Results ..... 37

    Demographics..... 37

*Convergent Validity*..... 37

*Reproducibility* ..... 42

    Discussion ..... 42

Conclusion .....	43
<b>Chapter 4: Availability and Effectiveness of Mobile Phone Delivered Interventions Aimed at Decreasing Sugar-Sweetened Beverage Consumption: A Systematic Review .....</b>	<b>45</b>
<b>Abstract.....</b>	<b>45</b>
<b>Introduction.....</b>	<b>47</b>
<b>Methods .....</b>	<b>48</b>
<b>Results .....</b>	<b>52</b>
<i>Study Characteristics .....</i>	53
<i>Types of Technology Utilized.....</i>	54
<i>Behavior Change Strategies and Theoretical Frameworks .....</i>	55
<b>Discussion .....</b>	<b>55</b>
<b>Limitations .....</b>	<b>59</b>
<b>Strengths.....</b>	<b>61</b>
<b>Conclusions.....</b>	<b>61</b>
<b>Chapter 5: Online Social Networking Worksite Wellness Intervention to Improve Beverage Consumption Patterns: The Healthy Beverage Habits Trial .....</b>	<b>63</b>
<b>Abstract.....</b>	<b>63</b>
<b>Introduction.....</b>	<b>65</b>
<b>Materials and Methods.....</b>	<b>68</b>
<i>Study Design.....</i>	68
<i>Study Participants .....</i>	70
<i>Intervention Development and Content .....</i>	70
<i>Data Collection Tools.....</i>	72
<i>Demographic and Anthropometric Data.....</i>	72
<i>Beverage Consumption .....</i>	72
<i>Social Media Usage Frequency and Online Social Support .....</i>	74
<i>Summative Evaluation .....</i>	74
<i>Statistical Analysis .....</i>	74
<i>IRB Approval and Consent.....</i>	76
<i>Compensation.....</i>	76
<b>Results .....</b>	<b>76</b>
<i>Reach and Representativeness and Demographics .....</i>	76
<i>Effect of Healthy Beverage Habits Pilot Study on Beverage Consumption .....</i>	81
<i>Social Media Usage Changes Over Time Between Instagram and E-mail Groups .....</i>	85
<i>Instagram Delivery.....</i>	86
<i>Thematic Analysis of Qualitative Themes.....</i>	87
<b>Discussion .....</b>	<b>90</b>
<b>Limitations .....</b>	<b>93</b>
<b>Strengths.....</b>	<b>94</b>
<b>Conclusions.....</b>	<b>95</b>
<b>Chapter 6: Conclusion and Future Directions .....</b>	<b>96</b>
<b>References .....</b>	<b>99</b>

<b>Appendices .....</b>	<b>117</b>
<b>Appendix A.....</b>	<b>117</b>
<b>Appendix B. ....</b>	<b>118</b>
<b>Appendix C.....</b>	<b>122</b>
<b>Appendix D.....</b>	<b>123</b>
<b>Appendix E.....</b>	<b>124</b>
<b>Appendix F. ....</b>	<b>135</b>
<b>Appendix G.....</b>	<b>136</b>
<b>Appendix H.....</b>	<b>137</b>
<b>Appendix I.....</b>	<b>139</b>

## List of Abbreviations

BEVQ-15	The Beverage Frequency Questionnaire-15
BMI	Body Mass Index
DHI	Digital Health Intervention
EDNP	Energy Dense Nutrient Poor
HBI	Healthy Beverage Index
HBM	Health Belief Model
HEI-2015	Healthy Eating Index
NNS	Artificially Sweetened Beverages or Non-Nutritive Sweeteners
OSSS	Online Social Support Scale
SCT	Social Cognitive Theory
SMS	Short Message Service
SSB	Sugar-Sweetened Beverage
TPB	Theory of Planned Behavior
WHP	Worksite Health Promotion programs

## Chapter 1: Introduction

Affecting more than 73.6% of the United States (U.S.) adult population over the age of 20 years, overweight, including obesity, is known to be influenced by genetics, behavior, social environment, and economics.<sup>1</sup> Negative health outcomes associated with obesity include a myriad of conditions including cardiovascular disease, type II diabetes, hypertension, stroke, dyslipidemia, osteoarthritis and reduced physical function, depression, and some cancers.<sup>2,3</sup> Numerous studies have shown that excessive sugar-sweetened beverage (SSB) consumption is associated with obesity,<sup>4,5</sup> diabetes,<sup>6-8</sup> and cardiovascular disease.<sup>5</sup>

Beverages alone account for almost half of all added sugars consumed by the U.S. population, the major sources of which include soft drinks, fruit drinks, sweetened coffee and tea, energy drinks, alcoholic beverages and flavored waters.<sup>9</sup> It is estimated that added sugars, or sugars not naturally occurring, account for more than 13% of calories per day in the U.S. population, whereas the current 2020-2025 Dietary Guidelines recommend limiting added sugars to 10% of total daily calories.<sup>10</sup> Furthermore recent studies looking at U.S. beverage consumption show that on average, Americans consume more than 11 teaspoons of added sugars each day from SSB alone.<sup>11</sup> Thus, reducing SSB consumption can dramatically impact the amount of added sugars consumed, making beverage consumption an ideal target for behavioral interventions aimed at reducing obesity and risk of associated co-morbidities.

Living in a rural community has also been associated with the consumption of more than three cans of SSB per day (approximately 30% of daily calories for 2,000 calorie diet), which is considerably higher than that of the national recommended intake level of 10% of daily calories.<sup>12</sup> For example, specifically in Appalachia adults consume three times more daily SSB calories when compared to the national average<sup>13,14</sup> making this population well suited for

targeted behavioral interventions aimed at reducing SSB consumption.

Despite the recent surge in community health and public health promotion due to the COVID-19 pandemic, there still remains much to be understood in regards to the determinants and processes of population-level health behavior change.<sup>15</sup> Due to the importance of community prevention efforts to public health practice and policy, it is critically important to obtain scientifically-based evidence of the most effective ways to stimulate community health behavior change in order to better inform public health promotion programs. If social influences are in fact a primary factor in the adoption of health behaviors<sup>16,17</sup> and “an individual’s behavior is shaped by a dynamic interaction with their social environment”,<sup>18,19</sup> research should study the effects a person’s social environment has on their health-related behaviors.

Relatively under-studied, the role of social support on health behavior change in the workplace is a critically important area that needs to be more understood. As companies move towards becoming more team-focused,<sup>16,17</sup> it becomes increasingly important to understand the shared social processes, as they can be positive influences on overall group interaction and dynamics and ultimately influence work efficiency. As social influences are a primary factor in the adoption of health behaviors,<sup>16,17</sup> ecological models postulate that an individual’s behavior is highly dependent on their interaction with their social environment.<sup>16,17</sup> This includes interpersonal, organizational, community, and policy level influences.<sup>18,19</sup> Several recent studies have shown that participants involved in lifestyle interventions for obesity often achieve greater weight loss results in groups versus those who are participate in an individual setting.<sup>20-23</sup> It has been suggested that social support systems be used to facilitate or mediate treatment outcomes, however their effects have not been well studied and require more research attention.<sup>20,24-27</sup>

Social media is one specific type of social support that is widely available, as social media usage is not dependent on socioeconomic factors such as race, education, and location. As such, social media users are more likely to be from lower-income households and the majority are accessing social media regardless of education and race or ethnicity.<sup>28</sup> With new estimates of approximately 70% of Americans using social media, access is becoming less of a barrier.<sup>29</sup> Moreover, for many users, social media is part of their daily routine. Roughly 75% of Facebook users and 60% of Instagram users visit these social networking websites at least once a day.<sup>29</sup> Additionally, around 70% of Americans engage in some type of online social network and the overwhelming majority of Millennials (85%) use social networking websites in their daily lives.<sup>29</sup>

The use of social media and social networks in targeted health-related interventions is a growing area of research with many studies enlisting the use of social networking websites as a resource to increase program adherence.<sup>30</sup> As an example, with the rise in internet-based social networking websites, social influence from anonymous online peers has been shown to be more successful for improving physical activity as compared to promotional messages.<sup>31</sup>

Online social support communities, such as social media networking websites and applications, have the unique ability to provide free and highly accessible benefits to the general population; which is increasingly relevant during the COVID-19 pandemic where there is limited access to health and human services.<sup>32</sup> Members of online support communities provide important opportunities for learning, social interaction, and support.<sup>33-35</sup>

Social networking sites remain an under-utilized platform for health promotion and social networking related to health. These types of social networking platforms deserve further investigation for their role in health behavior interventions. Overall, there is limited research

surrounding the role of online social support on an individual's beverage consumption patterns. This research will help to provide additional insight into ways in which beverage patterns can be improved through the use of online social networks and the support they provide. This will be accomplished by first updating the original version of the BEVQ-15, a rapid beverage questionnaire. Secondly, the current literature surrounding beverage consumption interventions provided by mobile technology will be assessed through a systematic review. Finally, a pilot trial assessing the effectiveness of an Instagram-delivered beverage consumption intervention will be conducted.

## **Chapter 2: Review of Literature**

### **Introduction and Rationale**

Obesity is the fifth leading global risk factor for mortality<sup>36</sup> and is a major health problem in both developed and developing countries, with higher incidences occurring in rural populations such as southwest Virginia.<sup>37</sup> Obesity and overweight affects 73.6% of the United States (U.S.) adult population over 20 years old<sup>1</sup> and is influenced by genetics, behavior, social environment, and economics: having enormous consequences to a person's overall health and well-being. Negative health outcomes associated with obesity include cardiovascular disease, type II diabetes, hypertension, stroke, dyslipidemia, osteoarthritis and reduced physical function, depression and some cancers, thus causing increased concern and economic burden.<sup>2,3</sup> The top two determinants of becoming overweight or obese is an individual's diet and physical activity levels, however, these two factors alone cannot adequately explain obesity's mechanism of action.<sup>38</sup>

Obesity is also seen to have a marked impact on the costs associated with absenteeism, sick leave, disability, injuries, and healthcare claims,<sup>39</sup> thus incentivizing employers to improve their employees' health through the implementation of worksite health promotion (WHP) programs in order to reduce healthcare costs.<sup>40</sup> Obesity prevention WHP may not only enhance employee self-confidence and improve the working relationship between management and workers, but also has the potential to boost the profitability of companies by increasing employee productivity and reducing medical and disability costs,<sup>41</sup> with even modest weight loss as low as 5% having been shown to reduce or eliminate co-morbidities associated with obesity.<sup>42</sup>

With close to 60% of the entire U.S. population currently in the workforce, worksite health and wellness programs might be useful to target sections of the population that would be difficult to recruit and otherwise not engage in community wellness programs.<sup>43</sup> These worksite-based programs may be particularly relevant to remote or rural workers and those with non-conventional schedules.<sup>43</sup>

## **Beverage Consumption**

Beverage consumption, as well as beverage intake, habits, and patterns have been extensively studied due to their high impact on human health. It has been well established that the overconsumption of sugar-sweetened beverages (SSB) can lead to significant health concerns in adults. Recent studies looking at U.S. beverage consumption showed that on average Americans consume more than 11 teaspoons of added sugars from SSB per day.<sup>11</sup> Researchers also found that water consumption in the U.S. was less than one liter per day, about a third of the recommended 2.7-3.7 liters per day.<sup>44,45</sup> Additionally, when SSB are consumed in place of water, total energy consumption increases 7.8%.<sup>46</sup> Thus, recommendations suggest replacing SSB with water or other low/no calorie beverage options as a viable strategy to reduce an individual's consumption of unnecessary calories and aid in weight management.<sup>10</sup>

Previous Dietary Guidelines Advisory Committees focused on the examination of specific foods and their relationships to negative health outcomes.<sup>47</sup> However, The Scientific Report of the 2020-2025 Dietary Guidelines Advisory Committee recommends that “research efforts are best aimed at targeting total beverage consumption rather than focusing on individual beverages”.<sup>10</sup> This change came about due to the inability to separate the effects of individual nutrients on an individual's overall health. Additionally, foods consumed have the ability to interact synergistically with one another in ways we do not fully understand.<sup>47</sup> It is through the

use of the dietary pattern approach that nutritional research has advanced through the collection of total food or beverage consumption habits and their relationship to an individual's overall health.<sup>47</sup>

### ***Healthy Beverage Index***

The recently developed Healthy Beverage Index (HBI) is a dietary assessment tool designed to evaluate overall beverage intake quality of ten beverages categories (including total fluid consumption and beverage calories).<sup>48</sup> The HBI is similar to the Healthy Eating Index (HEI-2015) which is a single summary measure of diet quality that is used to monitor changes in consumption patterns as well as serve as a useful tool for nutrition education and health promotion. The HBI was originally designed to overcome the HEI's limitation of adequately assessing overall beverage quality (i.e., kcal and fl oz) against the Dietary Guidelines for Americans and the Beverage Guidance Panel standards.<sup>49</sup> The HBI calculates total beverage consumption into several categories where respondents receive a numerical score. The overall index ranges from 0 to 100, with higher scores indicating a consumers' greater adherence to guidelines and better beverage consumption quality.<sup>49</sup> The components of the HBI can be seen in **Table 1**, adapted from Duffey and Davy.<sup>49</sup> For the purpose of this review, three specific components of the HBI are discussed further below.

Beverage Component	Description	Points
Water	Water comprises $\geq 20\%$ of fluid requirements	15
	No water consumption	0
	Water is $>0\%$ but $<20\%$ of fluid requirements	Proportional
Coffee and Tea	Unsweetened coffee and tea comprise $0\%$ – $40\%$ of fluid requirements	5
Low-fat Milk	$<1.5\%$ fat, fat-free, and/or soy milk comprises $0\%$ – $16\%$ of fluid requirements	5
Diet Drinks	Artificially sweetened beverages comprise $0\%$ – $16\%$ of fluid requirements	5
100% Fruit Juice	100% fruit juice comprises $0\%$ – $8\%$ of fluid requirements	5
Alcohol	Between 0–1 drinks for women, 0–2 drinks for men	5
Full-fat Milk	$0\%$ of fluid requirements come from 2% fat or full-fat milk	5
Sugar-sweetened Beverages	Sugar-sweetened beverages are $0\%$ – $8\%$ of fluid requirements	15
Total Beverage Energy	Energy from beverages $<10\%$ of total energy	20
	Energy from beverages $\geq 15\%$ of total energy	0
	Energy from beverages is $>10\%$ but $<15\%$ of total energy	Proportional
Met Fluid Requirements	Amount of beverages (mL) consumed was greater than or equal to fluid requirements	20
	Amount of beverages (mL) consumed was less than fluid requirements	Proportional

**Table 1:** Healthy Beverage Index (HBI) Components<sup>a</sup>

<sup>a</sup>Table adapted from Duffey and Davy<sup>49</sup>

### *Sugar-Sweetened Beverages*

Sugar-sweetened beverages alone account for almost half (47%) of all added sugars consumed by the U.S. population, with major sources including soft drinks, fruit drinks, sweetened coffee and tea, energy drinks, alcoholic beverages, and sweetened flavored waters.<sup>9</sup> It is estimated that added sugars, or sugars not naturally occurring, can account for more than 13% of calories per day in the U.S. population.<sup>9</sup> The current 2020-2025 Dietary Guidelines for Americans recommends limiting added sugars to 10% or less of total consumed calories per day.<sup>10</sup>

Research has shown that excessive SSB consumption is associated with obesity,<sup>4,5</sup> diabetes,<sup>6-8</sup> and cardiovascular disease,<sup>5</sup> especially with the large volumes of SSB that are consumed by the U.S. population.<sup>50</sup> In addition to SSB consumers having a strong association to certain metabolic and cardiovascular conditions, living in a rural community has also been associated with the consumption of more than three cans of SSB per day, considerably higher than that of the national recommend intake levels.<sup>12</sup> Specifically in Appalachia, adults consume three times more daily SSB calories as compared to the national average<sup>13,14</sup> making this

population ideal for targeted behavioral interventions aimed at reducing SSB consumption.

### ***Water and Fluid Requirements***

The consumption of adequate water is an essential component to life, physiological functions, and for maintaining continued body function. Low daily water intake and low urine output are accompanied with an increased risk of long-term kidney dysfunction,<sup>51,52</sup> hyperglycemia,<sup>53</sup> dehydration, and poorer cognitive performance.<sup>45,54</sup> The human body's internal fluid balance is controlled by homeostatic mechanisms which respond to the state of body water.<sup>55</sup> It is primarily the kidney's role to regulate the fluid balance and to keep it in check.<sup>55</sup>

The 2004 U.S. National Academy of Medicine provided guidelines for water intake and water balance.<sup>56</sup> The report concluded that requirements for water were highly dependent on a person's daily physical activity levels, climate, and diet.<sup>56</sup> Subsequently, there exists no single daily water requirement for an individual.<sup>57</sup> As a result, Adequate Intake volumes for water were developed for various life-stage groups (i.e., infant, child, adult, geriatric) and are composed of factors including desirable urine osmolality values and desirable total water intake per unit of dietary energy (Kcal).<sup>58</sup> The 2010 European Food Safety Authority report states that there can be no single water intake value that can meet the needs of everyone in a population due to differences between each individual's dietary patterns, kidney function, and water loss during excretion and secretion.<sup>58</sup> Therefore, the minimum water requirement for an individual is equal to the amount of water one losses and to prevent issues associated with lack of water consumption (i.e., dehydration) were established.<sup>57</sup> Current water consumption for U.S. adults is estimated to be less than one liter per day or about a third of the recommended 2.7-3.7 liters per day.<sup>44,45</sup>

One limitation specifically related to rurally isolated communities, like in Appalachia, is

the primary concern of clean and safe water.<sup>59</sup> Many residents may lack access to municipal water sources in their homes and rely on alternative sources of water, such as wells, natural springs, or expensive bottled water.<sup>59</sup>

### ***Total Beverage Energy***

The worldwide subject of obesity and the increases in total energy intake, specifically in the form of liquid calories, is an area of great concern and continued research. Increasing water consumption has been a key message used in many diet and weight reduction programs.<sup>60</sup> The addition of water to a persons' diet can be a way to dramatically reduce energy density<sup>61</sup> as drinking plain water is an effective way to provide adequate hydration without calories.<sup>62,63</sup> According to current dietary trends, higher levels of water consumption is an indicator of better dietary intake and therefore, low water consumption may be an indication of unhealthy beverage patterns.<sup>60</sup>

Beverage consumption is a significant contributor to the daily diet of U.S. adults and has been associated with overall health and wellbeing through several physiological pathways in the body.<sup>64</sup> Unfortunately, the over consumption of calorically dense beverages has begun to lead to an excess of energy intake.<sup>65</sup> Additional to the overconsumption of highly caloric liquid calories, research shows that calories consumed in liquid form may not provide the same satiety as solid calories, thus leading to increased energy intake beyond caloric needs.<sup>66</sup>

In examining the shifts in patterns and consumption of beverages between 1965 and 2002, Duffey and Popkin found significant increases in overall beverage calories from 222 calories per person per day from beverages in 1965 to 458 calories per day in 2002.<sup>65</sup> Additionally, the beverage patterns differed dramatically between the two time points with a considerable source of daily calories coming from not only a greater number of beverages, but by

increases in soda and alcoholic beverages.<sup>65</sup> In 2013, researchers assessed consumption patterns and individual-level associations using NHANES survey data from 1999 to 2008 and found that though prevalence of soda consumption fell, non-traditional SSB consumption rose (i.e., sports/energy drinks and fruit drinks), particularly across racial/ethnic subpopulations and those among low-SES populations.<sup>67</sup>

The reduction in energy intake through beverage consumption is a key factor to consider when targeting improvement in HBI scores as the consumption of excess calories through beverages dramatically increases daily energy consumption.<sup>11</sup>

### ***Measuring HBI Scores***

The difficulty in using 24-hour dietary recalls to measure dietary habits is that they are highly burdensome, time-intensive, and provide only recent dietary intake rather than habitual dietary patterns.<sup>68</sup> Conversely, a food-frequency questionnaire (FFQ) may be a reasonable alternative for measuring dietary intake for situations requiring longer periods of dietary intake information.<sup>68</sup> Additional advantages to using a FFQ include a lower burden to participants and researchers, less associated costs, and the ability to reasonably estimate a respondent's normally consumed foods over an extended period of time (i.e., habitual intake over weeks, months, or years).<sup>69</sup> FFQ also have the ability to capture dietary items not consumed on a daily basis, as dietary recalls only measure a few days of intake.<sup>70</sup>

The BEVQ-15, originally developed in 2010, is a valid and reproducible FFQ that can rapidly assess beverage consumption in adults<sup>71-73</sup> as well as estimate habitual average daily intake of beverages (kcal and fl. oz.) consumed across 15 categories and total SSB and total beverages.<sup>72,73</sup> Previous work has used the BEVQ-15, with modifications, to determine habitual HBI scores.<sup>74</sup> However, updates to the BEVQ-15 are needed in order to adequately reflect

current beverage intake trends<sup>75-78</sup> and more closely align with the HBI beverage categories. An update of the BEVQ-15 and evaluation of convergent validity and reproducibility will be critical in order to adequately calculate HBI scores. Additionally, the development and validation of a cloud or web-based BEVQ-15 will enhance beverage consumption tracking and data collection for future research endeavors.

## **Social Support Systems**

Due to the importance of community prevention efforts to public health practice and policy,<sup>79</sup> it is critically important to obtain scientifically-based evidence of the most effective ways to stimulate community health behavior change in order to better inform public health promotion programs.<sup>79</sup> Because social influences are a primary factor in the adoption of health behaviors,<sup>16,17</sup> and an individual's behavior is shaped by a dynamic interaction with their social environment,<sup>18,19</sup> research studying the effects one's social environment has on health-related behaviors would be illuminating.

Relatively under-studied, the role of social support on health behavior change is an area of growing importance.<sup>80</sup> As organizations move towards becoming more team-focused, it becomes increasingly important to understand the workplace dynamics, as they can be positive influences on overall group interaction and ultimately influence work efficiency.<sup>14</sup> As social influences are a primary factor in the adoption of health behaviors,<sup>16,17</sup> ecological models illustrate that a person's behavior is highly dependent on their social environment (i.e., interpersonal influences, organizational, community, and policy levels).<sup>18,19</sup>

Several recent studies have shown that participants involved in lifestyle interventions for obesity often achieve greater weight loss results in groups versus those who are participate in an individual setting.<sup>20-23</sup> It has been suggested that social support systems be used to facilitate or

mediate treatment outcomes, however, their effects have not been well studied.<sup>20,24-27</sup> It should also be noted that both positive and negative social support can significantly impact outcomes in group-based obesity behavioral treatment as greater perceived conflict is generally associated with lower weight loss and poorer rates of attendance.<sup>81</sup> On the other hand, higher attraction, or the desire to identify with and be accepted as part of the group, is associated with much greater attendance and better treatment outcomes.<sup>81</sup> Therefore, careful monitoring of group interaction on the part of the researcher is critical in promoting and maintaining positive interactions throughout the intervention.

## **Worksite Health Promotion**

Interest in employee health and the understanding of how employee health impacts overall productivity is a growing area of research.<sup>82-84</sup> The workplace is unique in that it presents a convenient setting for the introduction and maintenance of health-promotion programs for adults. Worksite Health Promotion (WHP) programs are a service typically provided by an employer and aimed towards improving the health and well-being of their workers, and in some cases their dependents.<sup>85</sup> WHP programs have common goals of promoting and maintaining good health behaviors and encouraging positive health behavior change.<sup>86</sup> WHP programs are becoming increasingly more popular and have been showcased in health reform proposals, the popular press, and congressional hearings.<sup>86</sup>

Typically, WHP programs contain a concentrated group of people who share a common purpose and common culture, with the added ability to reach large segments of the population that would not normally be exposed to or engaged in organized health improvement initiatives.<sup>85</sup> Additionally, the use of available administrative data collection and analysis systems that a

company collects on employees can be extremely useful to measure program impact.<sup>85</sup>

Increased interest in WHP may be due in part to many employers today associating poor health of employees with reduced performance, safety, and morale.<sup>85</sup> Workers who are in poor health and those with behavioral risk factors have the potential to increase a company's medical, disability, and workers' compensation expenses by contributing to elevated absenteeism and employee turnover, as well as having decreased productivity or presentism when at work.<sup>87-89</sup>

Absenteeism, or time away from work, can be more easily calculated as it is the time missed at work due to illness or chronic disease,<sup>90</sup> whereas presentism is a more complicated measure, referring to time spent at work, but with decreased levels of productivity.<sup>91</sup> This lack of performance in the workplace can often times be attributed to impaired mental or physical health and is a largely underestimated measure.<sup>91</sup> Overall, both absenteeism and presentism show a strong correlation with unhealthy employee behaviors such as poor management of long-term health conditions, obesity, low or lack of physical activity, depression, and insomnia.<sup>92</sup> Additionally, when workers work in close proximity one employee's poor health can negatively affect others working performance nearby.<sup>87-89,93</sup> Thus, improving the overall health of the workplace community may help to increase the overall performance of employees and reduce medical-related expenses to the company.

With more than 60% of Americans' health insurance coverage coming from an employment-based plan,<sup>94</sup> and the fact that most of an employees' days are spent in the workplace, good worker health has the potential to enhance the profitability of a company.<sup>85</sup> With evidence of high returns on employee wellness programs,<sup>41,95,96</sup> most U.S. companies now offer some form of wellness programming to their employees. In 2012, about half of U.S. employers with at least 50 employees and more than 90% with more than 50,000 employees

offered a workplace wellness program.<sup>97</sup> A recent survey noted that 77% of employers offering health benefits also offered some type of worksite health promotion program.<sup>98</sup>

Research has shown that the majority of unhealthy lifestyle behaviors that are associated with decreased productivity in employees can be modified through behavioral interventions.<sup>99</sup> Through specifically designed workplace interventions targeting unhealthy behaviors, researchers have seen marked reductions in presentism and absenteeism in those employees who participated.<sup>99</sup> Goals for interventions often determine achievement or improvement of employee health behaviors through monitoring changes in body mass, blood pressure, cholesterol, triglycerides, and glucose:<sup>100,101</sup> all of which are highly influential on employee health care costs, productivity, job satisfaction, absenteeism, a sense of community, and long-term health.<sup>102-104</sup>

Motivation for healthy behaviors can take many different forms and has the added benefit of being highly customizable based on available resources. Many WHP programs aim to offer motivational incentives through education, health coaching, monetary incentives, worksite facilities, free medical screenings and medical care, and company-wide wellness activities.<sup>99</sup> The most successful WHP programs have the ability to leverage incentives and rewards in order to help increase participation rates.<sup>105,106</sup> In fact, in a 2008 survey, employees in a wellness program indicated that the primary reason for participation were the financial incentives and the motivation for improved health came second.<sup>99</sup>

## **Technological Innovations**

Today, the majority of American adults (~95%) own a cellphone of some kind and 77% own smartphones or phones with internet capabilities.<sup>29</sup> Cell phone use covers a wide range of demographic groups, especially age.<sup>29</sup> Although, the use of smartphones is greater in Millennials (1981-1996) and Generation Xers (born 1965-1980) at 92% and 85% respectively, nearly 67% of

Baby Boomers (born 1946-1964) and 30% of those in the Silent Generation (born 1928-1945) operate smartphones.<sup>29</sup> At this time there is no data available on cell phone usage for Generation Z (born 1997-2015).

For many users, social media is part of their daily routine. Roughly 75% of Facebook users and 60% of Instagram users visit these social networking websites at least once a day.<sup>29</sup> Around 70% of Americans use online social networks with the overwhelming majority of Millennials (85%) using social networking websites in their daily lives.<sup>29</sup> Facebook usage breakdown by generation is 57% of Baby Boomers, 76% of Generation Xers, and 82% of Millennials. Usage rates for newer social networking platforms, such as Instagram and Snapchat, for Millennials is currently at 52% and 47% respectively.<sup>29</sup> Facebook is the most-widely used of the major social networking platforms, and its user base is most broadly representative of the population as a whole. Smaller shares of Americans use sites such as Twitter, Pinterest, Instagram and LinkedIn.<sup>29</sup>

In 2018, the percentage of U.S. adults who engaged in Instagram had risen to 35%, up from just 9% in 2012.<sup>29</sup> Specifically, the Instagram platform shows some differences between race, with 32% of white adults, 43% of black adults, and 38% of Hispanic adults engaging in the social media networking platform.<sup>29</sup> Instagram usage based on educational attainment ranges from 29% for those who completed “high school or less”, up to 42% for “college graduates”. Looking at urban and rural percentages, Instagram usage was reported to be 42% and 25%, respectively.<sup>29</sup>

## **Social and Health Support Networks**

The expanding reach and capacity of programs and tools has resulted in increasing interest in eHealth, i.e., eHealth weight loss strategies. Williams et al., conducted a

comprehensive systematic review of the literature which showed that social media is being commonly used as an intervention modality to improve a variety of outcomes related to diet and exercise.<sup>107</sup> Al-Eisa et al., discovered that participants from their “Instagram” intervention group performed considerably more physical activity sessions compared to the control group (i.e., no online social network) suggesting that the online platform, Instagram, might be a positive motivation to improve physical activity adherence levels among female college students.<sup>108</sup>

The use of social media and social networks in targeted health-related interventions is a growing area of research with many studies enlisting the help of social networking websites as a resource to increase program adherence.<sup>80</sup> The idea of using social influences, such as comradery and group dynamics has been an influencing factor in group-based health behavior interventions.<sup>80</sup> For example, with the rise in internet-based social networking websites, social influence from anonymous online peers has been shown to be more successful than promotional messages for improving physical activity in individuals.<sup>31</sup>

The simple act of receiving requests to connect as friends online is associated with reduced mortality but initiating friendships is not.<sup>109</sup> Additionally, online behaviors that indicate face-to-face social activity, such as posting photos, are associated with reduced mortality, but online-only behaviors, like sending messages, have a nonlinear relationship, where moderate use is associated with the lowest mortality. These results suggest that online social integration is linked to lower risk for a wide variety of critical health problems.<sup>110</sup>

### ***Online Social Support***

Typical with group-based interventions, motivators (i.e., community) help to keep participants engaged throughout the length of the intervention.<sup>114</sup> The social support and feelings of interconnectedness individuals experience with online social networks help to explain the

prolific growth of these platforms in everyday life<sup>111,112</sup> and may be a feasible platform for intervention delivery among young adults.<sup>113</sup> One study looking at Facebook found that larger networks and larger estimated audiences predicted higher levels of life satisfaction and perceived social support.<sup>111</sup> In a randomized controlled trial studying an internet-delivered walking program, increased use of the social media component (i.e., the “online community” feature embedded into the intervention webpage) was associated with improved weight-related outcomes.<sup>109</sup> Specifically, it was found that participants who entered the study with lower levels of baseline social support links (i.e., family, friends) were more likely to use the social networking component and were less likely to drop out of the study.<sup>109</sup>

Online social support communities, such as social media networking websites and applications, have the unique ability to provide free and highly accessible benefits to the general population, which is particularly relevant during the COVID-19 pandemic where there is limited access to medical help and services.<sup>32</sup> As with in-person support groups, members of online support communities provide one another with important opportunities for learning, social interaction, and support.<sup>33-35</sup> One of the major challenges that designers and developers of online communities deal with is the issue of how to facilitate social engagement and interaction among members of a group.<sup>114</sup> It is postulated that the Internet cannot support the same type of interaction between individuals as in face-to-face groups.<sup>115-117</sup> However, research has shown that participants of online support groups report that the information, social support, and empathy they gain from their online groups help them cope with their illnesses.<sup>33-35,116,118</sup> Online self-help group research suggests that these groups are valuable because they possess the advantages of mutual aid and the accessibility of technology.<sup>119</sup>

Not surprisingly, as researchers work to understand and record the effects of online

support groups, more and more people are turning to them in times of need.<sup>32</sup> The field of research on Internet communities is rapidly growing as researchers seek to understand the delicate relationship between online and offline communities and their group dynamics.<sup>32</sup> The debate between sociologists as to whether an online community can indeed be called a true community is still ongoing.<sup>120</sup> Social media networks are extraordinary in that they provide a ready community of social capital and a culture of general reciprocity,<sup>121</sup> in which members may come and go, existing at all times and providing a sense of continuity and stability.<sup>32</sup>

Social networking sites remain an under-utilized platform for health promotion and social networking related to health. These types of social networking platforms deserve further investigation for their role in health behavior interventions.

## **Social Media Networks and Health Behavior Change**

Multiple studies have reported benefits to using technology to enhance interventions for smoking cessation, diabetes management,<sup>122</sup> physical activity,<sup>123</sup> and weight loss.<sup>124</sup> Specifically, it has been shown that the use of technology is easily integrated into the lives of participants and allows for better flexibility for physicians and other healthcare providers when providing counseling and care to patients.<sup>124</sup> The use of online social networks to encourage healthy behavior change is quickly becoming more prevalent in the research arena. Extensive research has focused on the effectiveness of health behavior change interventions delivered via telephone<sup>125-128</sup> and the Internet,<sup>129-131</sup> and recently research has turned towards exploring newer interactive delivery channels, such as mobile telephone messages,<sup>132-135</sup> Facebook messages,<sup>136-138</sup> and Instagram.<sup>108,139</sup> Short message service (SMS), otherwise known as text message-delivered, interventions have positive short-term behavioral outcomes,<sup>140</sup> which may be an indication of success for other mobile phone delivery channels, such as smartphone applications.

Interestingly, higher levels of mobile telephone usage is associated with lower levels of self-rated health,<sup>141</sup> higher body mass index (BMI),<sup>142</sup> and engaging in health-compromising behaviors.<sup>143</sup> Hence, a mobile phone delivery channel for health behavior change interventions may be the most promising for WHPs and populations suffering from poorer health.<sup>140</sup>

The entire effect of social networks on health related outcomes and monitoring is difficult to ascertain in the available literature.<sup>139</sup> The usefulness of social networking platforms in health promotion and social networking related to health has been sorely overlooked. These types of social networking platforms deserve further investigation for their role in health behavior interventions.<sup>139,144</sup> Social media is an ideal fit for potential behavioral interventions as it provides asynchronous and constant communication between researchers and participants, removes physical barriers (i.e., participants with transportation, mobility, or illness to participate interactively), and adds a level of anonymity for participants to discuss sensitive subjects.<sup>139</sup>

Social media has been credited with providing a cost-effective way to increase user interaction, provide peer-to-peer support, and widen access to health interventions.<sup>145</sup> Internet-delivered obesity interventions may also be more cost-effective than in-person interventions.<sup>146,147</sup> For example, one study demonstrated that the use of a web-based program has the ability to reduce actual health care costs.<sup>148</sup> Social networking sites such as Facebook, Twitter, and Instagram offer a potential boost to the typical worksite wellness intervention through the incorporation of social networking. However, though Facebook and Twitter have been utilized in multiple behavioral change research studies,<sup>149</sup> research on Instagram's viability is lacking. This may be due, in part, to the relative newness of the online social networking application, nonetheless, the use of Instagram has been growing exponentially.<sup>29</sup>

## ***Weight Loss***

The literature examining the relationship of social support and weight loss is somewhat mixed.<sup>150</sup> While the majority of studies show that increases in social support are related to weight loss<sup>136</sup> or improvements in weight loss-related behaviors,<sup>151-153</sup> there have been some that fail to find benefits from social support for weight loss outcomes.<sup>154,155</sup> One recent study showed that a very-low-intensity intervention that was delivered entirely by mobile technology had the ability to produce short-term, modest weight loss.<sup>156</sup> In a randomized control trial by Richardson et al., increased use of the social media component was associated with improved weight-related outcomes. In addition to increased weight loss, it was found that participants who entered the study with less baseline social supports (i.e., family, friends) were more likely to use the social media component and lower dropout rates resulted within the group.<sup>109</sup>

In a systematic review by Semper et al., smartphone applications aimed towards self-regulation of diet for weight loss found that although there was not a statistically significant difference in the amount of weight lost, participants in the smartphone application groups in all reviewed studies lost at least some bodyweight.<sup>157</sup> Engagement in Twitter and Facebook support groups were both significantly associated with weight loss.<sup>86,136-138</sup> However, despite the widespread use of social media, few studies have quantified the effect of social media networking in online weight management interventions.<sup>139</sup>

Despite the positive associations of using social media to promote improved health behaviors, a systematic review of social media's influence on weight management showed that mainstream social media networking platforms such as Facebook, Twitter, and Instagram were used in only 15% of studies, with the majority being from more recent publications.<sup>139</sup> This low number may indicate “a move from program-specific, investigator-developed interventions to

those that capitalize on media that participants already frequent.”<sup>139</sup>

Personalized feedback has been used as a behavioral change technique to incorporate within internet-delivered weight loss interventions.<sup>158</sup> Informational support (providing suggestions or advice) has been found to be a main source of social support in other weight loss interventions delivered via Twitter.<sup>137</sup> However, results from a meta-analysis revealed no differences between internet-delivered weight loss interventions with personalized feedback and control interventions  $\geq 12$  months.<sup>159</sup> Additionally, results from another review indicated that regardless of the type of technology-based program, it must be used continuously throughout the intervention period to significantly impact weight loss.<sup>160</sup>

## **COVID-19**

Finally, a recent demand for online social support related health behavior change programs is due to the current COVID-19 pandemic, during which many countries enacted Stay at Home and Social Distancing policies further highlighting the need for online social support.<sup>161</sup>

Apart from hand washing, physical restrictions (i.e., social distancing, quarantine, or isolation) quickly became the primary preventative effort to combat the spread of the COVID-19 disease.<sup>161</sup> The long-term ramifications resulting from the extended period(s) of isolation and loneliness resulting from these social distancing restrictions are yet to be seen. However, previous research of general social isolation and loneliness found associations with poorer mental and physical health.<sup>162</sup> Unique to COVID-19 is the wide access to varying degrees of social media platforms, all of which are helpful in promoting resilience to stress and trauma.<sup>163</sup>

## **Theoretical and Conceptual Framework**

When considering social media and networking driven behavior changes, it is important to consider possible behavior change theories to help guide behavioral interventions, such as the Theory of Planned Behavior (TPB).<sup>164</sup> The Talking Health trial is an example of using integrated

behavioral theories to reduce SSB intake.<sup>165</sup> The SSB intervention arm, SIPsmartER, an SSB reduction intervention, demonstrated a moderate to large effect size for reducing SSB intake, when compared to MoveMore, the matched-contact physical activity control arm.<sup>165</sup>

### ***Theory of Planned Behavior (TPB)***

The TPB is a commonly used theory for predicting and understanding health behaviors and has been applied to a wide variety of health contexts, including dietary behaviors. The TPB posits that behavioral intention is the most proximal determinant of a person's behavior and that both behavioral intention and perceived behavioral control can adequately predict behavior.<sup>166,167</sup> Behavioral intention refers to what an individual's plans, rather than hopes, to do, and perceived behavioral control refers to the beliefs related to the perceived ease or difficulty of completing a particular behavior.<sup>166,167</sup> Perceived behavioral control can exert a direct effect on behavior, as well as an indirect effect through behavioral intentions.<sup>166,167</sup>

Other antecedents to behavioral intentions include an individual's attitudes (i.e., one's positive or negative evaluation towards performing the behavior) and subjective norms (i.e., one's perception about the social expectations and motivation to comply with those expectations). One RCT of university graduate students found that in a 13 week physical activity study, those who were placed in the online network arm of the study and therefore received social influence from anonymous online peers were more successful than those receiving promotional messages alone.<sup>153</sup> Simply put, individuals will be more willing to change if they feel like it will be easy rather than a difficult process. Additionally, having a positive attitude and perceived social support significantly contribute to an individual's success.

### **Health Behavior Message Prompts**

One way to help encourage participants become more involved in a behavioral health

intervention is through the use of periodic messaging.<sup>164</sup> Periodic prompts are messages, reminders, or brief feedback that is communicated to participants multiple times over the course of a health behavior intervention.<sup>164</sup> These prompts can be delivered by the research team at pre-designated intervals (i.e., daily, weekly, or monthly) and can be sent using a variety of technologies (i.e., email, telephone, mail, etc.).<sup>164</sup> Health behavior interventions using periodic prompts have utilized technology, such as the Internet, to allow messages to be sent directly to participants at no cost.<sup>164</sup> Furthermore, a review of the most current literature surrounding the use of periodic prompts shows that they can be an effective tool in behavior change interventions.<sup>164</sup>

An important consideration is the use of language in Instagram posts (i.e., tone, content, and length of messages).<sup>168</sup> Though language is our primary way of communication, it is vitally important to consider that all modes of communication play a critical role in how we create and perceive meaning.<sup>164</sup> Public health nutrition initiatives have focused on encouraging populations to change health related behaviors, such as reduction in energy dense nutrient poor (EDNP) food and beverage intake.<sup>169,170</sup> However, the main challenges exist in translating complex health information into messages that participants find relevant.<sup>171</sup> Therefore, health authorities have embraced social media to aid in the expansion and reach of health-related messages.<sup>171</sup> Development, implementation, and evaluation of these health messages are critical to the success of any campaign which is designed to influence health behavior change.<sup>172</sup>

The ability of researchers to create and ultimately achieve the correct tone, content, and length of messages for motivational message delivery is a challenging endeavor. A common criticism of physical activity text messaging interventions is the majority of studies fail to provide information on the initial development of messages.<sup>173</sup> Message development needs to be carefully considered prior to any program implementation.<sup>174</sup>

## **Digital Health Interventions in the Workplace**

Behavior and lifestyle interventions are currently the first recommended step in the treatment and management of obesity.<sup>175</sup> However, health behavior is multifaceted and involves numerous psychological and behavioral aspects.<sup>176</sup> Unfortunately, randomized control trials evaluating the effectiveness of interventions targeting lifestyle behavior change have shown mixed and marginal effects in targeted behaviors.<sup>177-181</sup> Furthermore, evidence shows that only a small amount of the weight loss achieved by behavioral interventions is maintained over time,<sup>182</sup> and weight regain is high in lifestyle interventions involving behavior and weight change.<sup>176</sup> Nonetheless, most experts argue that long-term treatment is essential in sustaining new behavioral modification changes.<sup>183</sup>

Although behavioral interventions targeting improvements in diet and physical activity are an effective way to help people lose weight and decrease chronic disease risk factors,<sup>184</sup> they are shown to be time and resource intensive, not only on the part of the researcher but for participants as well. Participants of these types of programs describe feeling that face-to-face weight-loss interventions are time consuming and inconvenient,<sup>185</sup> thus impacting program adherence and efficacy. One way in which health behavioral researchers are overcoming current face-to-face intervention issues is through the incorporation of social media digital health interventions to reduce burdens on participants to participate.<sup>186</sup>

A systematic review assessing the impact of digital health interventions in the workplace on health-related outcomes of employee participants found that there was modest evidence that digital-only interventions have a positive impact on health-related outcomes in the workplace.<sup>92</sup> Of the 22 studies that were reviewed, all were RCTs and all but one were found to have significant improvements in at least one health-related measure, yet all had mixed findings.<sup>92</sup> It

appears that digital-only interventions are the most beneficial when they are deeply rooted into the work environment and target specific health behaviors that are routinely conducted while employees are at work. However, in cases when the targeted health issues are of increased complexity, a digital-only intervention may not be sufficient and a more multicomponent intervention, one which includes human support, may be a better approach.<sup>187</sup>

With the current literature showing how WHP programs have seen great success in reducing healthcare costs<sup>188</sup> and improving lifestyle behaviors such as poor diet and lack of physical activity,<sup>189</sup> the natural incorporation between WHP and digital health interventions to improve health behavior may be a valuable way for behavioral health researchers to have the ability to widely disseminate health education while gathering data and monitoring employee engagement simultaneously.

## **Conclusion**

In conclusion, research has shown that participants involved in lifestyle interventions for obesity often achieve greater weight loss results in groups than individually.<sup>20-23</sup> Additionally, with close to 60% of the entire U.S. population currently in the workforce and close to 95% of American adults owning a cellphone of some kind and 77% owning smartphones,<sup>29</sup> worksite health and wellness programs might be a useful tool to target sections of the population that would be difficult to recruit and otherwise not engage in community wellness programs.<sup>43</sup>

WHP not only demonstrates the ability to enhance employee self-confidence and improve the working environment, but also has the potential to boost the profitability of a company by increasing employee productivity and reducing medical and disability costs,<sup>41</sup> making it a win-win for both employers and employees. Digital health interventions have the added benefit of providing cost-effective ways to increase user interaction, provide peer-to-peer support and

widen access to health interventions.<sup>145</sup> With the use of these WHP, and the incorporation of digital health interventions, researchers can widely disseminate health education to a specific population while gathering data on behavioral changes and monitoring employee engagement simultaneously.

On a larger scale, social-media delivered behavioral interventions administered through employees' workplaces may be the most practical, accessible, and reliable mode of delivery. Being available 24/7 helps to ensure participants have access and can engage at their own leisure while creating a community of employees may help to boost participation. Moreover, given the rise in people working from home and in the overall increase of social distancing, the ability to be a part of an intervention without having to leave the comfort and safety of one's home may be a promising avenue of research to consider.

Online social support communities, such as social media networking websites and applications, have the unique ability to provide free and highly accessible benefits to the general population; which is increasingly relevant during the COVID-19 pandemic where there is limited access to health and human services.<sup>32</sup> Members of online support communities provide important opportunities for learning, social interaction, and support.<sup>33-35</sup> However, there is limited research surrounding the role of online social support on an individual's beverage consumption patterns. This research will help to provide additional insight into ways in which beverage patterns can be improved through the use of online social networks and the support they provide. This will be accomplished by first updating the original version of the BEVQ-15, a rapid beverage questionnaire. Secondly, the current literature surrounding beverage consumption interventions provided by mobile phone technology will be assessed through a systematic review. Finally, a pilot trial assessing the effectiveness of an Instagram-delivered beverage

consumption intervention will be conducted.

## **Chapter 3: Update of the BEVQ-15, a Beverage Intake Questionnaire for Habitual Beverage Intake for Adults**

### **Abstract**

**Introduction:** The BEVQ-15 is a beverage intake questionnaire which estimates habitual average daily intake of 15 beverage categories (kcal and fl oz) as well as total sugar-sweetened beverages (SSB) and total beverages. However, since its initial validation in 2010, it has not been updated. The purpose of this investigation was to assess the convergent validity and reproducibility of the updated form of the BEVQ-15 to better reflect current beverage consumption trends.

**Methods:** The study population included adults (n=50) aged 18 years or older, recruited from a local university community. Participation consisted of three laboratory visits within a four-week period in which the updated BEVQ-15 was administered during the first and last visit and four 24-hour dietary recalls were collected. BEVQ-15 modifications included removing limits of 60 fl oz per beverage, adding a nut milk category, and providing creamer and sweetener preferences for coffee/tea categories. Convergent validity was assessed by comparing reported beverage intake between the BEVQ-15 and dietary recalls. Reproducibility was assessed by comparing both BEVQ-15 administrations. Analyses included descriptive statistics, Wilcoxon Signed Rank tests, Bland-Altman plots, and Spearman's correlations.

**Results:** For validity, Bland-Altman plot agreement between the BEVQ-15 and recalls ranged 92-96% for total SSB and total beverage intake. For reproducibility, all beverage categories, total SSB, and total beverage intake were significantly correlated between the two BEVQ-15 administrations ( $r=0.41-0.85$ ;  $p\leq 0.01$ ).

**Conclusions:** This updated version of the BEVQ-15 demonstrated moderate convergent validity and reproducibility for total beverage consumption among well-educated southwest Virginia adults.

## **Introduction**

Contrasting to 24-hour food recalls, which are highly burdensome, expensive, and inappropriate for assessment of past dietary habits,<sup>68</sup> a food-frequency questionnaire (FFQ) may be a reasonable alternative for measuring dietary intake.<sup>68</sup> Advantages to using FFQ include a lower burden to participants and researchers, less associated costs, and the ability to reasonably estimate a respondent's normally consumed foods over an extended period of time (i.e., habitual intake over weeks, months, or years).<sup>69</sup> FFQs also have the ability to capture dietary items not consumed on a daily basis, as dietary recalls only measure a few days of intake.<sup>70</sup>

Using beverage consumption data derived from the BEVQ-15, a Healthy Beverage Index (HBI) score can be calculated. The HBI, a dietary assessment tool designed to evaluate overall beverage intake quality of eight beverages categories (including total fluid consumption and beverage calories),<sup>48</sup> is used to monitor changes in consumption patterns as well as serve as a useful tool for nutrition education and health promotion. The HBI has the ability to calculate total beverage consumption into several categories or components where respondents receive a numerical score ranging from 0 to 10, with higher scores indicating a consumers' greater adherence to guidelines and better beverage consumption quality.<sup>49</sup> Using the BEVQ-15 to calculate HBI, illustrates the versatility of the questionnaire in both research and clinical settings.

The purpose of this investigation was to determine the convergent validity and reproducibility of an updated version of the BEVQ-15, a beverage intake and frequency questionnaire. The BEVQ-15, originally developed in 2010, is a convergently valid and reproducible FFQ that can rapidly assess beverage consumption in adults<sup>71-73</sup> as well as estimate habitual average daily intake of beverages (kcal and fl oz) consumed across 15 categories and total SSB and total beverages.<sup>72,73</sup> Administration time of the BEVQ-15 is ~2.5 minutes and the

Flesch-Kinkaid grade level is 4.8.<sup>72</sup> In order to adequately reflect current beverage intake trends,<sup>75-78</sup> such as the increasing consumption of dairy-free/nut milks and sugar-sweetened sports drinks, and to increase applicability to other populations with high fluid intake, such as athletes, the BEVQ-15 required several updates. Due to several significant modifications to the BEVQ-15, such as the new addition of more commonly consumed nut milks<sup>190</sup> (i.e., almond, cashew, coconut) and sports drinks,<sup>191</sup> while also removing the limited ceiling threshold of 60 fl oz for all beverage categories, the convergent validity and reproducibility must be confirmed for the new version.<sup>69,192</sup>

## **Methods**

### ***Participants and Design***

For this observational investigation, adults (n=50) aged 18 years or older were recruited from a local university community between August 2016 and February 2017. Recruitment methods included university email listservs targeting students, faculty and university staff, as well as local dispersion of recruitment flyers. For participants, the singular inclusion criteria had a minimum age of 18 years. Study protocol was approved by the Virginia Tech Institutional Review Board (IRB protocol number: 16-552, approved June 17, 2016) (**Appendix A**) and participants provided written informed consent before enrollment.

Participants visited the laboratory three times at two-week intervals. Visit one included the following procedures in this order: participants provided information on demographic characteristics, filled out an updated BEVQ-15 (i.e., BEVQ-1) and then completed a 24-hour dietary recall. An unannounced dietary recall was administered via phone before visit 2.

At visit two, participants completed a third 24-hour dietary recall. A final dietary recall (unannounced) was completed over the phone before visit three. At visit three, participants

completed the updated BEVQ-15 again (i.e., BEVQ-2) and were compensated \$15. Dietary recalls were conducted using the USDA's Multiple Pass Method<sup>193</sup> by three trained researchers who were supervised by a PhD level Registered Dietitian Nutritionist. In order to capture relative dietary patterns, dietary recalls were timed to include three weekdays and one weekend day and were then analyzed using nutritional analysis software (NDS-R: Nutrition Data System for Research, 2015, University of Minnesota, Minneapolis). In order to provide consistency, the same researcher collected all recalls from a single participant. Mean beverage intake from the four dietary recalls was used for all analyses.

### ***Development and Scoring of the Updated BEVQ-15***

Several major modifications were made to the original BEVQ-15. First, as the previous version had a maximum limit of 60 fl oz/day for any individual beverage, the ceiling limit was removed to make it more applicable to other populations such as athletes. This was accomplished by adding an open-ended space for participants to indicate a specific amount of a beverage consumed. Second, a nut milk category (i.e., almond, cashew, or coconut milk) to accommodate additional dairy-free milk options was added.<sup>194</sup> Finally, several creamer and sweetener preferences within the coffee and tea categories were added to help differentiate between calorically or artificially sweetened products. Several minor modifications included the addition of more detailed instructions, combining both the whole and reduced fat milk into a single category and combining all diet and artificially sweetened beverages into one single category.

To score the updated BEVQ-15, frequency ("How often") is converted to the unit of times per day, then multiplied by the amount consumed ("How much each time") to provide average daily beverage consumption in fluid ounces. Energy and grams (per fl oz) for each beverage category were determined using food composition tables,<sup>195</sup> NDS-R 2015, and

MyPlate.gov.<sup>196</sup> To quantify total SSB consumption, beverage categories containing added sugars were summed (sweetened juice beverage/drinks, regular soft drinks, regular energy and sports drinks, tea sweetened with sugar, and tea and/or coffee sweetened with sugar and/or sweetened creamer). See **Figure 1** for the updated version of the BEVQ-15. Detailed instructions for scoring procedures are available upon request from the corresponding author.

# Beverage Questionnaire (BEVQ-15)

Participant ID: \_\_\_\_\_

Date: \_\_\_\_\_

## Instructions:

- For the past month, please indicate your intake for each beverage type by marking an "X" in the bubble for "how often" and "how much each time".
1. Indicate how often you drink the following beverages, for example, if you drank 5 glasses of water per week, mark 4-6 times per week.
  2. Indicate the approximate amount of beverage you drank each time, for example, if you drank 1 cup of water each time, mark 1 cup under "how much each time". If applicable, indicate the specific type of beverage by marking an "X" in the bubble by the one used (i.e., type of nut milk).
  3. When trying to estimate your intake throughout the day, (i.e., water) think about the total amount you drink. For example, 3 times per day and 20 fl oz each time = 60 fl oz per day. **If you consume more 60 fl oz per day select "1 time per day" and write the TOTAL daily amount in the last column.**
  4. Do not count beverages used in cooking or other preparations, such as milk in cereal.
  5. Count milk/creamer added to tea and coffee in the tea or coffee with creamer beverage category, NOT in the milk categories; this includes non-dairy creamer. Please indicate the type of creamer (flavored, plain or sugar-free) and sweetener used by marking an "X" in the bubble by the one used, if applicable.

Type of Beverage	HOW OFTEN (MARK ONE)							HOW MUCH EACH TIME (MARK ONE)					
	Never or less than 1 time per week (go to next beverage)	1 time per week	2-3 times per week	4-6 times per week	1 time per day	2 times per day	3+ times per day	Less than 6 fl oz (¾ cup)	8 fl oz (1 cup)	12 fl oz (1½ cups)	16 fl oz (2 cups)	20 fl oz (2½ cups)	> 20 fl oz (specify TOTAL daily amount)
Water or unsweetened sparkling water	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
100% Fruit Juice	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
Sweetened Juice Beverage/Drink (fruit punch, juice cocktail, Sunny Delight, Capri Sun)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
Whole Milk: red cap, Reduced Fat Milk 2%: purple cap, or Chocolate Milk	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
Low Fat 1%: green cap, Fat Free/Skim Milk: light blue cap, Buttermilk or Soy Milk	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
Nut Milk (almond, cashew, coconut) <input type="radio"/> Flavored, Original, or Plain <input type="radio"/> Unsweetened	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
Soft Drinks, Regular	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
Energy & Sports Drinks, Regular (Red Bull, Gatorade, Powerade)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
Diet or Artificially Sweetened Soft Drinks, Energy & Sports Drinks (Diet Coke, Crystal Light, artificially sweetened sparkling water, Sugar-Free or Total Zero Red Bull, Powerade Zero)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
Sweet Tea (with sugar)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
Tea or Coffee, black (no creamer or milk) <input type="radio"/> Sugar, <input type="radio"/> Artificial Sweetener, <input type="radio"/> N/A	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
Tea or Coffee (w/ milk &/or creamer) <input type="radio"/> Sugar <input type="radio"/> Artificial Sweetener <input type="radio"/> N/A Milk &/or Creamer: <input type="radio"/> Milk <input type="radio"/> Half & Half or Cream <input type="radio"/> N/A Creamer: <input type="radio"/> Flav. <input type="radio"/> Plain <input type="radio"/> Sugar-Free	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
Wine (red or white)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
Hard Liquor (vodka, rum, tequila, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
Beer, Ales, Wine Coolers, Non-alcoholic or Light Beer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
Other (list): _____	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____

VirginiaTech, 2016.

**Figure 1.** The Updated Beverage Intake Questionnaire for Adults (BEVQ-15)\*  
\*Scoring instructions are available from corresponding author upon request.

## *Data Analysis*

Statistical analyses were performed using SPSS statistical analysis software (version 24.0 for Windows, 2016 SPSS Inc., Chicago, IL). Descriptive statistics (mean  $\pm$  standard deviation and frequencies) are reported for demographic characteristics and mean average daily consumption of beverages, including total SSB and total beverages, are reported for the BEVQ-15 and dietary recalls (fluid ounces [fl oz] and kilocalorie [kcal]). As total beverage fl oz and kcal were not normally distributed in the dietary recalls or BEVQ-15, non-parametric tests were used.<sup>197</sup> To assess the convergent validity of the updated BEVQ-15, the BEVQ-2 responses for each beverage category were compared to beverage consumption reported by the 24-hour dietary recalls via Wilcoxon Signed Rank Tests. As the BEVQ-15 assesses beverage intake over the past month, the second administration of the BEVQ-15 (i.e., BEVQ-2) was used to examine convergent validity as it covered the same timeframe as the 24-hour dietary recalls. To assess test-retest reproducibility, responses from both administrations of the BEVQ-15 (i.e., BEVQ-1 and BEVQ-2), were compared via Wilcoxon Signed Rank tests. Associations between beverage intake variables for convergent validity and reproducibility were assessed using correlational analyses (Spearman's  $r$ ). FFQ are considered reproducible if they report correlations ranging from 0.5 to 0.7.<sup>198,199</sup> To further assess agreement in total SSB and total beverage consumption, two major outcomes of interest, between the BEVQ-15 and dietary recalls, Bland-Altman analyses were performed as they are extensively used to evaluate the agreement between two instruments or measurements.<sup>200</sup> Acceptable agreement is considered 95% of mean differences within  $\pm 2$  standard deviations of the mean difference.<sup>201-204</sup>

## Results

### *Demographics*

Participants were 56% female, primarily white (82%), college-educated (72%), and had a mean age  $34.9 \pm 16.8$  years (ranging 18 to 78 years). Participant retention rate was 100% with no dropouts.

### *Convergent Validity*

Of the 15 beverage variables, total SSB, and total beverage intake assessed (fl oz and kcal), significant, but minimal, differences in consumption between the two assessment tools (BEVQ-2 and dietary recalls) were reported for low fat or fat free milk (fl oz and kcal), nut milk (fl oz and kcal), regular soft drinks (fl oz and kcal), and total SSB (kcal). The mean significant differences ranged from 0.4 to 1.1 fl oz and 5-21 kcals. All variables, including total SSB and total beverage intake were significantly correlated ( $r=0.29-0.79$ , all  $p \leq 0.05$ ) (See **Table 1**). To further explore the magnitude of differences in major beverage outcomes, Bland-Altman analyses were used to evaluate the level of agreement between the BEVQ-15 and dietary recalls.

The mean differences in total SSB fl oz and kcals were -0.8 (CI: -3.4, 1.9) and -21 (CI: -46, 4), respectively. The mean differences in total beverage fl oz and kcals were -4.5 (CI: -13.4, 4.5) and 30 (CI: -16, 77), respectively. Bland-Altman demonstrated agreement that was slightly below an acceptable level between the BEVQ-2 and the dietary recalls for reported total SSB fl oz and kcal intake (94% and 92%, respectively) and total beverage fl oz and kcal intake (94% and 96%, respectively) (**Figure 2**).



**Table 1.** Convergent validity and reproducibility of the updated Beverage Intake Questionnaire (BEVQ-15): Comparison to a 4-day dietary intake recall and results of two BEVQ-15 administrations

Beverage Category	Convergent Validity <sup>a</sup>				Reproducibility <sup>b</sup>		
	BEVQ-2	Recalls	Difference <sup>c</sup>	Correlation	BEVQ-1	Difference from BEVQ-2 <sup>c</sup>	Correlation
	Mean (SD)	Mean (SD)	Mean (SE)	r	Mean (SD)	Mean (SE)	r
<b>Water</b>							
fl oz	41.6 (32.8)	45.6 (30.0)	4.0 (4)	0.75***	54.7 (45.5)	13.1 (5.0)**	0.70***
<b>100% Fruit Juice</b>							
fl oz	0.8 (1.3)	1.0 (1.8)	0.2 (0.3)	0.36*	1.0 (2.0)	0.2 (0.2)	0.54***
kcal	14 (23)	18 (32)	3 (5)	0.36*	18 (35)	4 (4)	0.54***
<b>Sweetened Fruit Drink</b>							
fl oz	0.5 (1.3)	0.7 (1.5)	0.2 (0.2)	0.33*	0.3 (1.2)	0.2 (0.2)	0.41**
kcal	7 (19)	10 (22)	2 (3)	0.33*	4 (18)	3 (3)	0.41**
<b>Whole Milk, Reduced Fat Milk, or Chocolate Milk</b>							
fl oz	2.4 (7.7)	1.4 (3.7)	1.0 (0.9)	0.76***	2.6 (6.3)	0.2 (1.0)	0.85***
kcal	47 (152)	27 (73)	20 (18)	0.77***	51 (125)	3 (20)	0.85***
<b>Low Fat or Fat Free Milk, Buttermilk, or Soy Milk</b>							
fl oz	1.3 (2.8)	0.8 (2.2)	0.7 (0.4)*	0.48**	1.9 (4.2)	0.6 (0.5)	0.63***
kcal	16 (34)	9 (27)	7 (5)*	0.48**	23(51)	7 (6)	0.63***
<b>Nut Milk</b>							
fl oz	1.4 (5.2)	0.3 (1.2)	1.1 (0.6)**	0.29*	1.7 (4.9)	0.3 (0.6)	0.80***
kcal	12 (51)	2 (10)	10 (6)**	0.44**	15 (48)	2 (5)	0.78***
<b>Regular Soft Drink</b>							
fl oz	2.1 (5.8)	2.5 (5.0)	0.4 (0.8)*	0.76***	1.7 (4.4)	0.4 (0.3)	0.75***
kcal	28 (77)	33 (67)	5 (10)*	0.76***	23 (59)	5 (10)	0.75***
<b>Energy &amp; Sports Drinks</b>							
fl oz	0.5 (2.3)	0.6 (2.4)	0.1 (0.2)	0.33*	0.9 (4.3)	0.4 (0.3)	0.44**
kcal	7 (32)	8 (34)	1 (2)	0.33*	12 (60)	5 (4)	0.44**
<b>Diet or Artificially Flavored Sweetened Drinks</b>							
fl oz	2.7 (8.2)	3.9 (9.4)	1.3 (1.4)	0.71***	2.9 (8.4)	0.2 (0.6)	0.80***
kcal	1 (3)	1 (3)	0 (0)	0.71***	1 (3)	0 (0)	0.80***
<b>Sweet Tea</b>							
fl oz	0.5 (1.7)	0.7 (2.3)	0.2 (0.3)	0.69***	0.8 (2.4)	0.3 (0.1)*	0.80***
kcal	5 (17)	7 (23)	2 (3)	0.69***	8 (24)	3 (1)*	0.80***
<b>Coffee/Tea – Black</b>							
fl oz	7.8 (12.3)	9.3 (11.3)	1.5 (1.3)	0.50***	8.5 (13.2)	0.7 (1.1)	0.76***

kcal	6 (18)	3 (4)	3 (3)	0.38**	6 (19)	0.2 (4)	0.62***
<b>Coffee/Tea - Sweetened/Milk/Cream</b>							
fl oz	3.8 (6.8)	2.5 (5.3)	1.3 (0.9)	0.31*	4.4 (8.1)	0.7 (0.6)	0.80***
kcal	16 (27)	20 (43)	5 (5)	0.36*	22 (47)	7 (5)	0.82***
<b>Wine</b>							
fl oz	1.3 (3.0)	1.1 (2.3)	0.2 (0.3)	0.79***	1.7 (3.3)	0.4 (0.2)	0.81***
kcal	27 (62)	23 (47)	4 (5)	0.79***	35 (68)	8 (5)	0.81***
<b>Hard Liquor</b>							
fl oz	0.4 (1.1)	0.2 (0.4)	0.2 (0.1)	0.29*	0.5 (1.1)	0.1 (0.2)	0.81***
kcal	27 (75)	11 (27)	17 (66)	0.29*	34 (76)	6 (10)	0.81***
<b>Beer</b>							
fl oz	1.5 (2.2)	2.5 (4.4)	1.0 (0.5)	0.65***	2.3 (2.9)	0.8 (0.3)*	0.80***
kcal	15 (22)	26 (46)	10 (5)	0.65***	24 (30)	8 (3)*	0.80***
<b>Total Sugar-sweetened Beverages</b>							
fl oz	6.2 (9.1)	6.9 (9.1)	0.8 (1.3)	0.35*	7.6 (11.0)	1.4 (9.0)	0.74***
kcal	63 (102)	84 (115)	21.0 (12.5)*	0.41*	71 (117)	8 (12)	0.76***
<b>Total Beverage Intake</b>							
fl oz	68.6 (41.4)	73.0 (35.1)	4.5 (4.4)	0.71***	85.9 (51.8)	17.3 (5.4)***	0.74***
kcal	230 (254)	199 (169)	30 (23)	0.70***	276 (221)	46 (24)*	0.67***

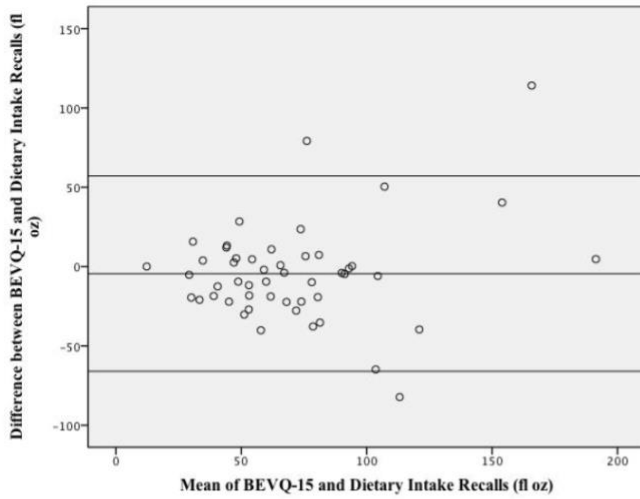
<sup>a</sup>Convergent validity as determined by comparing the second administration of the BEVQ-15 to mean reported intake from four dietary intake recalls

<sup>b</sup>Reproducibility as determined by comparing two administrations of the BEVQ-15.

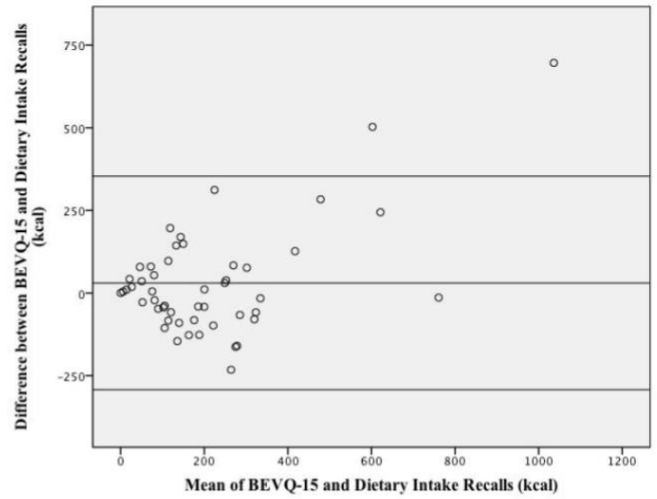
<sup>c</sup>Slight differences may be noted from the preceding columns due to rounding.

\* $p \leq 0.05$ ; \*\* $p \leq 0.01$ ; \*\*\* $p \leq 0.001$

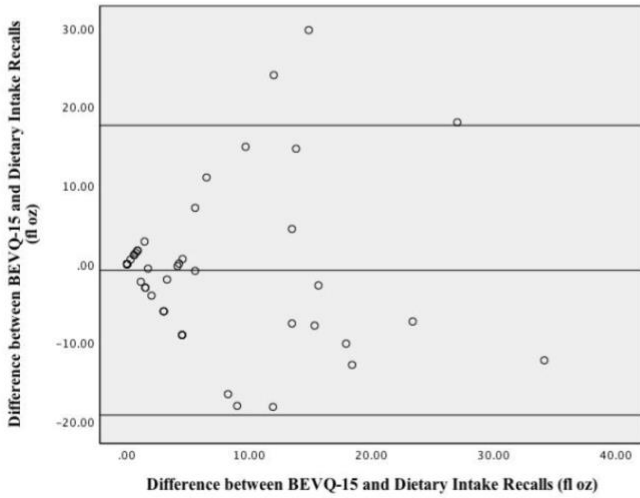
**Figure 2.** Bland-Altman analysis of the Updated BEVQ-15\* and Dietary Intake Recalls for (a) Total beverage fl oz; (b) Total beverage kcal; (c) Total sugar-sweetened beverages fl oz; and (d) Total sugar-sweetened beverages kcal\*\*



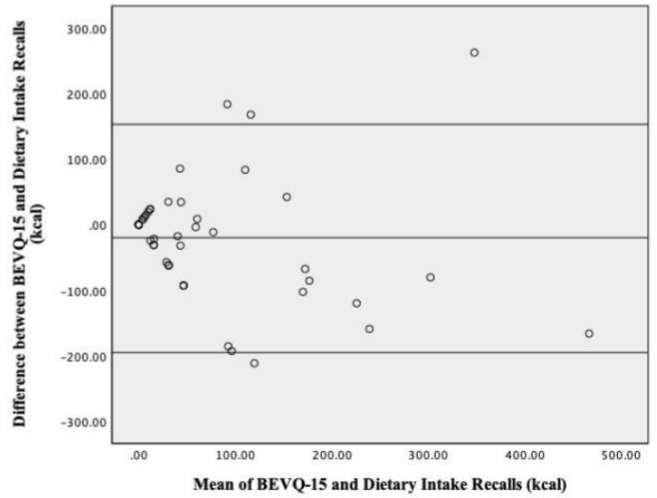
a. Total Beverage fl oz



b. Total Beverage kcal



c. Sugar-sweetened Beverage fl oz



d. Sugar-sweetened Beverage kcal

\*The second administration of the BEVQ was used for this analysis.

\*\*The center line represents the mean difference and the upper and lower lines indicate the mean  $\pm$  1.96 standard deviation.

## ***Reproducibility***

Significant differences in water (fl oz), beer (fl oz and kcal), sweet tea (fl oz and kcal), and total beverage (fl oz and kcal) were measured between the two administrations of the BEVQ-15 (BEVQ-1 and BEVQ-2). However, all 15 beverage categories as well as total SSB and total beverage intake were significantly correlated from the first to the second administration of the BEVQ-15 with  $r = 0.41$  to  $0.85$  ( $p \leq 0.01$ ) (See **Table 1**).

## **Discussion**

This updated version of the BEVQ-15 demonstrates moderate convergent validity and reproducibility as a rapid measure of habitual beverage consumption for this well-educated adult population in southwest Virginia. With the dynamic nature of food availability,<sup>205</sup> subjective dietary assessment tools require periodical updating to reflect current dietary consumption patterns.

Typically, Bland-Altman plots demonstrating  $\geq 95\%$  consensus are considered acceptable agreement between assessment tools.<sup>201-204</sup> Bland-Altman analyses indicated slightly below, or acceptable agreement, between the updated BEVQ-15 and dietary recalls for SSB and total beverage intake that ranged 92-96%. Although no significant differences were detected, it is important to note that slight variances are expected due to the different time periods covered by the BEVQ-15 as compared to dietary recalls (habitual vs recent intake).

Typically, FFQ are considered reproducible if they report correlations ranging from 0.5 to 0.7.<sup>198,199</sup> The majority of beverage categories, including total SSB and total beverage intake, fell within this range (0.54-0.85,  $p \leq 0.001$ ). Although sweetened juice drinks and energy/sports drink correlations were slightly below the acceptable range (0.41-0.44,  $p \leq 0.01$ , respectively), values were not significantly different between the two BEVQ-15 administrations. Water and total

beverage fl oz were found to be significantly different between time one and time two (mean difference of 13 and 17 fl oz, respectively), which could be attributed to a heightened awareness of beverage consumption habits during the second administration. Although the BEVQ-15 measures intake over the past month, it is possible that seasonal changes may have occurred to cause the significant change in beverage consumption.<sup>206</sup> While significant differences were reported for sweet tea and beer kcals (3 and 8 kcals, respectively), the differences were not of practical significance.

Several limitations were noted. The first of which being reliance on self-reported dietary intake data, which is subject to reporting errors and potential bias.<sup>198</sup> To address this potential area of concern, a PhD-level Registered Dietitian Nutritionist supervised all 24-hour recall collection using a multiple pass method<sup>207</sup> and analysis and nutritional analysis software (NDS-R) was employed. A second limitation was the narrow diversity in racial/ethnic profiles and educational attainment of our sample population which was highly educated compared to the U.S. as a whole. Future research would benefit from a more diverse participant pool. A third possible limitation to the validation analyses could be an associated learning effect, however, per the original validation of the BEVQ, timing of either the BEVQ or food recalls did not significantly impact the validity of the FFQ.<sup>71</sup> As face validity was not performed on the updated version of the BEVQ-15, a final limitation is the chance of bias risk derived from the possibility of respondents interpreting and responding to the items incorrectly.

## **Conclusion**

This updated version of the BEVQ-15 provides a dietary assessment tool that has the ability to rapidly assess total beverage consumption. This updated version of the BEVQ-15 demonstrates moderate convergent validity as compared to 24-hour dietary recalls within a well-

educated adult population living in southwest Virginia. With the update, ceiling limits for beverage categories were removed and several new categories were added including a nut milk and creamer and sweetener preferences within the coffee/tea categories. Future research should focus on validating this updated version for various populations, such as children and athletes, and investing in a cloud or web-based version in order to increase beverage consumption tracking and data collection.

## **Chapter 4: Availability and Effectiveness of Mobile Phone Delivered Interventions Aimed at Decreasing Sugar-Sweetened Beverage Consumption: A Systematic Review**

### **Abstract**

**Background:** There is a current need for effective interventions to decrease sugar-sweetened beverage (SSB) intake. Mobile phone technology is emerging as a promising mode of delivery for behavior change interventions, including those that aim to decrease SSB intake.

**Objective:** Assess availability and effectiveness of mobile phone-delivered interventions in which reduced SSB intake was either a primary or partial intervention objective.

**Methods:** Inclusion criteria included studies of smartphone applications and text message interventions in which the consumption of SSB was an objective of the study. Studies related to disease management were excluded (e.g., alcoholism, kidney disease, etc.). Study characteristics and results were gathered and synthesized according to PRISMA guidelines.

**Results:** A total of 17 articles were eligible for inclusion. Of the included studies, 11 (65%) were successful at promoting a decrease in SSB consumption as a result of the intervention. Studies which used multiple modes of technology were more successful at reducing SSB. The majority of included studies (88%) used some form of self-monitoring to promote behavior change.

**Conclusions:** Technology-based interventions utilizing text messages, mobile phones, and self-monitoring technologies can be an effective means of decreasing SSB intake in various populations, particularly if used in conjunction, as the utilization of multiple modes of technology may prove to be more effective in meeting SSB reduction goals. More rigorous trials that determine what parts of the technology or intervention component was most effective are necessary for further evaluation of mobile-delivered beverage consumption interventions.

**Study registration:** This systematic review was registered with PROSPERO: CRD42020196909

**Keywords:** beverage consumption; technology; eHealth; mHealth; mobile phone; cell phone;  
sugar-sweetened beverages

## Introduction

Recent studies looking at United States (U.S.) beverage consumption patterns showed that, on average, Americans consume more than 11 teaspoons of added sugars from sugar-sweetened beverages (SSB) per day.<sup>13</sup> Research has shown that excessive SSB consumption is associated with obesity,<sup>4,5</sup> diabetes,<sup>6-8</sup> and cardiovascular disease,<sup>5</sup> especially with the large volumes of SSB that are consumed by the U.S. population.<sup>50</sup> The current 2020-2025 Dietary Guidelines for Americans recommends limiting added sugars to 10% or less of total consumed calories per day.<sup>10</sup>

The adoption of mobile technology can be seen world-wide as its utilization for interpersonal communication and infrastructure has been growing at a rapid rate.<sup>208-211</sup> The use of mobile technology in dietary interventions is steadily increasing, especially related to decreasing SSB consumption.<sup>212</sup> Current advancements in mobile phone technology have made it a desirable method for public health promotion and population level disease prevention efforts.<sup>213</sup> The use of mobile technology is also increasingly used to promote health and prevent disease.<sup>210,214-218</sup> Mobile health (mHealth) is the use of mobile phone technology to deliver health care.<sup>219</sup> mHealth has been used because it offers an interactive form of communication, which provides a wide range of opportunities for intervention methods.<sup>214,220</sup> Currently, the majority of Americans (~95%) own a mobile phone of some kind and 77% own smartphones or phones with Internet capabilities.<sup>221</sup> Mobile phone use covers a wide range of demographic groups, while smartphone ownership exhibits greater variation based on age, household income and educational attainment.<sup>221</sup>

Multiple studies have reported benefits to using technology to enhance interventions for smoking cessation, diabetes management,<sup>222</sup> physical activity,<sup>223</sup> and weight loss.<sup>224</sup> Specifically,

studies report that the use of technology is easily integrated into the lives of participants and allows for better flexibility for physicians and other healthcare providers when providing counseling and care to patients.<sup>224</sup> Extensive research has focused on the effectiveness of health behavior change interventions delivered via telephone<sup>225-228</sup> and the internet.<sup>229-231</sup> However, research has turned towards exploring newer interactive delivery channels, such as mobile telephone messages,<sup>220,232-234</sup> Facebook messages,<sup>138,235,236</sup> and Instagram.<sup>108,237</sup> Short message service (SMS), otherwise known as text message-delivered, interventions have positive short-term behavioral outcomes,<sup>215</sup> which may be an indication of success for other mobile phone delivery channels, such as smartphone applications.

More research is needed to establish the availability and effectiveness of mobile interventions. Various gaps in the literature exist including most effective intervention delivery methods, behavioral theory, and intervention length on effectiveness need to be addressed. The study characteristics that are associated with effective mHealth studies to reduce SSB need to be identified and an understanding of what is the best study design and for what group of people (i.e., age and technology preference) does mHealth work best are key questions that need to be addressed. Therefore, this systematic review was conducted to determine the availability and effectiveness of mobile phone delivered interventions aimed at decreasing SSB consumption.

## **Methods**

This review was conducted using the Preferred Reporting items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines,<sup>238</sup> and was registered with PROSPERO (CRD42020196909). The publication identification stage entailed searching online databases (**Figure 1**) with the following keywords and combinations of keywords: (beverage\* OR drink\*) AND (eHealth OR electronic health\* OR mobile health\* OR m-Health OR mHealth OR

“Telemedicine” OR cell phone\* OR cellphone\* OR cell-phone\* OR cellular phone\* OR smart phone\* OR smartphone\*). The search strategies for each of the other databases (Web of Science, Cinahl, Scopus, and Engineering Village) were adapted from the original PubMed (MEDLINE database) search. The review was limited to clinical trials, meta-analysis, randomized controlled trials, validation studies, journal articles, and reviews published before June 2020. Given the limited available research in this subject area, a lower bound for date restriction was not applied.

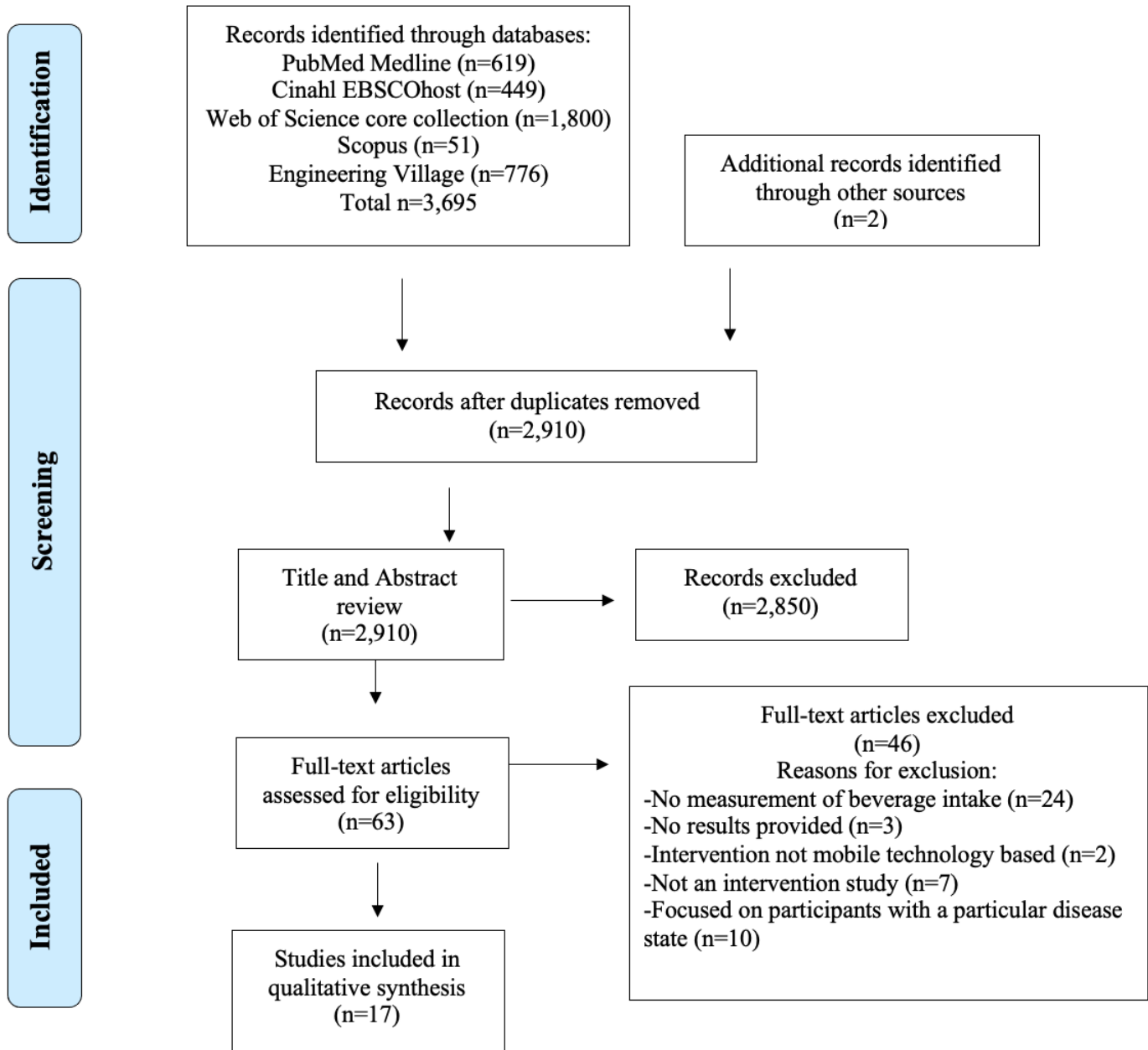
Criteria for inclusion in this review required a partial or entirely digitally delivered intervention targeting healthy behaviors. The program or intervention must have used a type of mobile phone/device-delivered technology with either a primary or secondary goal of lowering SSB intake. Mobile phone-delivered technologies included, but were not limited to, SMS or text messages, E-mails, phone calls, and mobile phone applications, including social media platforms such as Facebook and Twitter. Web-delivered intervention studies were excluded unless mobile phone use was specified. Studies that applied both digital and face-to-face modes of delivery within a single intervention or program were eligible for inclusion, provided the digital component was the primary mode of intervention delivery and the delivery method used to administer the intervention’s content was clearly specified. As a digital component was required, there was no limit on the participant’s age. Studies related to disease management were excluded (e.g., diabetes, alcoholism, and kidney disease).

A total of 3,695 references were initially retrieved and after search filters/limits were applied, related citations sought, and duplicates removed, 2,910 citations were imported into the reference management software EndNote X9 for Macintosh. Titles and abstracts were reviewed to determine if the full-text article should be reviewed. If all eligibility criteria were not apparent (e.g., mode of delivery) the full-text article was screened.

Out of 2,910 imported records, 63 articles remained for full review after applying the above criteria. Figure 1 presents an overview of the review process according to the PRISMA 2020 Flow Diagram for new systematic reviews which included searches of databases, registers, and other sources.<sup>238</sup> During this stage, the following data were extracted: author(s), year published, population and location, study design, objective/purpose, technology used, outcome measures, and findings/results.

Risk of bias and study quality was assessed using the 2018 Mixed-Method Appraisal Tool (MMAT).<sup>239,240</sup> The MMAT is a validated appraisal tool used to determine quality of study design to be used in the context of systematic reviews and includes five categories of study design: (a) qualitative, (b) randomized controlled trial, (c) nonrandomized, (d) quantitative descriptive, and (e) mixed methods.<sup>241</sup> Each category consists of five categories, all rated as either “yes,” “no,” or “can’t tell.”<sup>241</sup> This tool was selected based on the variety of study designs included in this review, including randomized controlled trials, non-randomized studies, and mixed-method studies. The tool allowed for comparison between multiple study designs. Two reviewers independently used the MMAT to evaluate the quality of the included studies. Any discrepancies were discussed, and consensus was reached.

**Figure 1.** Flow diagram of the systematic review of mobile phone delivered interventions aimed at decreasing sugar-sweetened beverage consumption



## Results

After screening the full text to determine if the articles met the inclusion criteria, 17 articles were included in the qualitative analysis.<sup>242-258</sup> Recent literature related to availability and effectiveness of mobile beverage technology-based interventions aimed at decreasing intake of SSB is summarized in **Table 1** (see **Appendix B**).

### *Sugar-Sweetened Beverages*

Eleven of the seventeen studies (65%) were successful in significantly reducing SSB consumption from baseline levels.<sup>242,243,245,248-251,253,258-260</sup> In a 12-week RCT on young adults 18-35 in Australia, the intervention group significantly improved SSB intake (P=0.02) compared to the control group, decreasing average SSB intake by 429.0 (858.3) mL/week.<sup>261</sup> A 20-week RCT adolescent boys 12-14 in Australia found significant intervention effects for SSB consumption (mean:  $-0.6 \pm 0.26$  glass/day; P=0.01).<sup>258</sup>

The remaining showed no significant change in SSB consumption or dietary related behaviors.<sup>247,257,262-265</sup> **Table 2** illustrates the effectiveness of mHealth to reduce SSB by various study characteristics. (see **Appendix C**).

All SSB data was obtained using various methods of self-reported data from participants. Most studies utilized one or two items on self-reported questionnaires to assess the participants' intake of SSB over an average day or week. Additional SSB intake measures included food records and a report of perceived changes in SSB intake,<sup>250</sup> random 24-hour recalls,<sup>253</sup> image-based dietary assessment technique using before and after photos to quantify SSB intake,<sup>254</sup> and text messaging to quantify SSB intake.<sup>257</sup>

### *Study Characteristics*

The included studies reported sample sizes ranging from 12 to 361 participants with a variety of young and middle-aged participant groups. Of the included studies, 41% (n=7) involved adolescents or participants younger than 18 years.<sup>244,250,252-254,257,258</sup> No studies recruited or included participants older than 65 years of age. Of the studies analyzed, 76% (n=13) included both male and female participants, while 3 studies included only male participants,<sup>247,252,258</sup> and 1 study included only female participants.<sup>256</sup>

Almost half of the articles were conducted in Australia (n=8),<sup>242,246-248,251,252,255,258</sup> with the remaining taking place in the United States (U.S.) (n=6),<sup>243-245,253,256,257</sup> Belgium (n=1),<sup>249</sup> Sweden (n=1),<sup>254</sup> and the United Kingdom (U.K.) (n=1).<sup>250</sup> Length of intervention periods ranged from 3-weeks to 6-months. The most common intervention periods were 12-14-weeks (n=5)<sup>242,243,248,249,255</sup> and 6-months (n=5)<sup>244,246,251,253,254</sup> in length.

A randomized control trial (RCT) design was used in the majority of the included studies (76%, n=13).<sup>242,244,246,248,249,251-255,257,258,265</sup> Single-arm interventions were used in the remaining 24% of studies (n=4).<sup>243,245,247,250</sup> Seven of the studies had minimum body mass index (BMI) requirements for participants to participate.<sup>242,244,245,248,249,253,255</sup>

Assessment of study quality of all included articles were generally medium to high in terms of study design as scored through the Mixed Methods Appraisal tool (MMAT) (**Appendix D**).<sup>241</sup> Unclear judgements were due to insufficient study details. Unfavorable responses (i.e., “can’t tell” or “no”) stemmed from lack of methodological information provided from articles, blinding of participants, and small sample sizes (pilot trials). Dietary assessment of beverage intake was classified as having a high risk of bias because data were self-reported. Significant levels of dropout limited statistical conclusions in several of the studies.

The overall age of study participants did not correlate to effectiveness of reducing SSB. None of the studies found a sex effect associated with the intervention's outcomes. Though interventions took place over various periods of weeks and/or months, reduction of SSB and intervention length did not correlate. Finally, no differences were seen between study design related to SSB reduction.

### ***Types of Technology Utilized***

Of the included articles, 42% (n=7) used only 1 mode of technology to deliver the intervention,<sup>243,245,247,257,262-264</sup> 29% (n=5) used 2 modes of technology,<sup>249,250,258,260,265</sup> and 29% (n=5) used 3 or more modes of delivery throughout the intervention.<sup>242,248,251,253,259</sup> The studies which used multiple modes of technology were more successful at significantly reducing SSB (i.e., achieved significant reduction of SSB as compared to a control group). As an example, the 20-week RCT of adolescent boys aged 12-14 years old conducted in Australia found significant intervention effects for SSB consumption (P=0.01) or an average reduction of 0.6 glasses (~150 ml) per day.<sup>258</sup> Alternatively, the six studies which were not effective in reducing SSB consumption all used only one or two modes of technology.<sup>247,257,262-265</sup>

A variety of technologies were used to deliver intervention materials and feedback to participants including SMS or text messaging 59% (n=10),<sup>242,243,248,251,253,257,259,260,262,265</sup> mobile applications 59% (n=10),<sup>242,247-251,258,259,263,264</sup> intervention websites 35% (n=6),<sup>242,248,253,258-260</sup> E-mails 24% (n=4),<sup>242,248,253,259</sup> phone calls 18% (n=3),<sup>242,251,259</sup> and social media 12% (n=2),<sup>245,249</sup> with one using Facebook groups<sup>249</sup> and the other using Twitter.<sup>245</sup>

Except for in-person contact for baseline and regular assessments, interventions were delivered completely virtually and participants did not meet in person during the study period for 65% (n=11) of the reviewed research articles.<sup>242,243,245,249,250,257,259,260,262,264,265</sup> Thirty-five percent

(n=6) reported using face-to-face intervention techniques in addition to mobile technology, but the mobile phone-delivery method remained the primary delivery method for the intervention.<sup>247,248,251,253,258,263</sup>

### ***Behavior Change Strategies and Theoretical Frameworks***

Several different strategies were used to promote health behavior change in the included intervention studies. Eighty-eight percent (n=15) of the included studies used some type of self-monitoring component,<sup>242,243,245,248-251,253,257-259,262-265</sup> and 59% (n=10) of studies included goal setting as part of the intervention.<sup>242,248-251,253,258-260,265</sup> One study used financial incentives to promote behavior change.<sup>247</sup>

Additionally, behavioral theory and behavioral frameworks were specified in all but 35% (n=6) of included studies,<sup>245,247,249,250,262,265</sup> including Social Cognitive Theory (35%, n=6)<sup>253,257,258,260,263,264</sup>, Self-Determination Theory (18%, n=3)<sup>251,258,263</sup>, Transtheoretical Model (18%, n=3)<sup>242,248,259</sup>, RE-AIM (6%, n=1)<sup>243</sup>, and Control Theory (6%, n=1).<sup>242</sup> Two studies reported using two guiding theories or behavioral frameworks,<sup>242,263</sup> however, there was no association between behavioral theory, framework type, or number used on effectiveness of the study to improve consumption of SSB.

## **Discussion**

This systematic review revealed that mobile phone-delivered interventions can be a promising method for decreasing SSB intake across a variety of different ages and geographical areas. SSB intake is a feasible dietary behavior to target as the primary outcome of a mobile phone-delivered intervention or as part of interventions targeting other health behaviors. This review also indicated that mobile technology can be used to promote beneficial changes in SSB intake when used as the primary mode of intervention delivery or when used in conjunction with

traditional weight loss interventions (i.e., face-to-face, cohorts). Based on these findings, studies which employ multiple methods of technology or modes of communication see greater results when targeting SSB reduction.

In regards to understanding what makes mobile interventions successful, researchers evaluated several components. It appears that age and sex of participants did not influence intervention success. In terms of study design, neither the duration of intervention nor the behavioral framework influenced study success as both successful and unsuccessful interventions varied greatly in both length and theory. The use of a digital only or combination (digital and face-to-face) designs were also evenly distributed between successful and unsuccessful interventions. One component that did appear to predict success was the number of delivery methods used throughout the intervention. Those interventions that were successful in reducing SSBs, often used multiple modes of mobile technology (E-mail, phone calls, text messaging, mobile phone application, intervention website, social media, etc.). Of the six studies which were not successful at reducing SSB consumption, five only used one form of mobile technology (two text messaging only, three mobile phone application only).

Comprehensive systematic reviews of the literature have shown that technology has been used to enhance interventions for smoking cessation, diabetes management,<sup>122</sup> physical activity,<sup>123</sup> and weight loss.<sup>124</sup> Technology is easily integrated into the lives of participants and allows for greater flexibility for physicians and other healthcare providers when providing counseling and care to patients.<sup>124</sup> In a RCT targeting physical activity among female college students, participants from the “Instagram” intervention group performed considerably more physical activity sessions compared to the control group (i.e., no online social network) suggesting that the online platform, Instagram, might be a positive motivation to improve

physical activity adherence.<sup>108</sup>

Many of the included interventions (88%) included self-monitoring as a way to promote behavior change.<sup>242,243,245,248-251,253,257-259,262-265</sup> Self-monitoring varied from logging food intake using a paper diary or a smartphone application to responding to text messages asking about daily intake of different dietary components such as SSB. Dietary self-monitoring has shown to be an effective behavior change strategy by raising a person's awareness of what they are eating.<sup>266</sup> With mobile technology now readily accessible, together with the level of interest in mobile technology amongst young adults, collecting dietary intake data using mobile devices may lead to improved cooperation to record diet in this age group as a means to promoting behavior change.

A RCT design was used in the majority of the included studies. In clinical research, RCTs are considered the gold standard for ascertaining the efficacy and safety of a treatment and are used to answer patient-related questions, including behavioral dietary interventions. The remaining studies can still provide valuable information about the potential utility of mobile interventions for promoting decreases in SSB intake, but the methodological limitations should be considered in evaluation of the overall conclusions of this systematic review. Many of the less rigorous studies that were included were pilot studies or feasibility studies that were intended to provide preliminary data about the effectiveness of the interventions before scaling up for more rigorous testing, such as a large-scale RCTs.

Among the studies included, the populations receiving the intervention varied greatly, which makes comparison between the effectiveness of the interventions difficult. The participants in the included studies varied based on age, country of origin, and occupation, which can all contribute to the effectiveness of interventions to promote behavior change. 65% of the

studies were conducted outside of the U.S..<sup>242,246-252,254,255,258</sup> Therefore, studies focusing on particular cultures and using culture specific measurement tools cannot be generalized to populations in other countries. It is evident that SSB intake is problematic worldwide, with the U.S. exhibiting higher intake of SSB in relation to other high-income countries such as Australia or European countries.<sup>267</sup>

When designing future interventions to address SSB intake, these factors should be considered to tailor interventions to the specific population targeted.

A little over half of the studies reported power calculations to determine appropriate sample size.<sup>242,245,247,249,257-259,262-265</sup> Of those, three were forced to restrict sample size to below this number due to lack of participation and difficulty in recruiting participants.<sup>243,260,262</sup> However, it should be noted that the power calculations were based on the primary outcome of interest, which, for most studies included, was not SSB intake, therefore, caution should be exercised in interpreting the effectiveness of the interventions on decreasing SSB intake.

Furthermore, there is much evidence to prove that the way a message is framed can affect a person's receptiveness to personal diet behavior change. Development, implementation, and evaluation of health messages are a critical step to the success of any dietary behavioral intervention.<sup>268</sup> Conclusions cannot be drawn about whether using a specific theoretical basis made interventions more effective, but as noted by the National Cancer Institute, using a theoretical basis for an intervention can improve its likelihood of success by conceptualizing the specific mechanisms for health behavior change.<sup>269</sup>

Many of the studies' weaknesses included the use of convenience sampling and small sample sizes. Although affordable, easy and readily available to subjects,<sup>270</sup> convenience samples

can be unpredictable due to their vulnerability to biases, particularly if the group being studied is not representative of the population of interest. Additionally, self-reported measures such as weight and diet behaviors were also used in a large majority of the studies included in the analyses. Because of bias and imprecision, self-reported energy intakes should be interpreted with caution unless independent methods of assessing their validity are included in the experimental design.<sup>62</sup>

SSB intake was measured exclusively by self-reported measures (i.e., beverage consumption surveys), but notably, many different questionnaires were used, which could limit the comparability of the studies. Often food frequency-type questionnaires were used to measure SSB intake, and the time periods varied from measuring daily SSB intake to measuring weekly SSB intake. Similarly, studies differed in whether they measured actual daily or weekly intake or “typical” intake. Implementing the use of a standardized questionnaire for measuring beverage intake can provide more detailed outcome measures and reduce ambiguity in the beverages classified as SSB.

## **Limitations**

One possible detractor for this systematic review is that half of the studies, 53% (n=9), identified through the process did not have the primary purpose of reducing SSB intake.<sup>242,243,247-249,258,260,262,263</sup> Interestingly, among these studies, six of them still demonstrated decreases in SSB as a result of the intervention.<sup>242,243,248,249,258,260</sup> This may indicate that SSB can be feasibly decreased as part of a larger weight loss or lifestyle intervention as a measurable target of those interventions.

Another important factor to consider is the strength of the evidence reported from these studies. Not all of the reviewed studies were randomized controlled trials, introducing potential

biases (i.e., sample selection and instrumentation biases). Many studies failed to mention the reliability and validity of questionnaires or instruments used to measure outcomes. One study, conducted by Buis et. al., 2013, used a non-validated researcher-developed instrument,<sup>271</sup> further reducing generalizability and reliability of results.

The review was limited to studies referenced in PubMed, Web of Science, Cinahl, Scopus, and Engineering Village. Unpublished studies and those not referenced in the previous search engines were not identified. Therefore, this review is subject to publication bias.

Another possible limitation is the use of mobile technology often requires participants to have access to a personal mobile phone with either text messaging capabilities or smartphone with a data plan. This limits generalizability to only those participants who can afford the technology or to interventions able to provide smartphones to participants, as was done in one of the included studies.<sup>257</sup> Additionally, more information is needed on the long-term effects of mobile health interventions.

Another limitation is the use of a technology-based intervention's effectiveness on multiple populations such as adolescents and the elderly population. Forty-one percent of the studies reviewed included adolescents those younger than 18 years of age.<sup>244,250,252-254,257,258</sup> Without further research, it is unknown whether this type of intervention would be effectively integrated into the lifestyles of elderly people or whether they would be discouraged and have difficulty engaging in this type of technology. Therefore, the results of this systematic review indicate that the positive effects of mobile phone-delivered technology on beverage consumption patterns cannot be generalized to the entire population.

## **Strengths**

Strengths of the given systematic review include the use of two reviewers to screen all articles for inclusion and complete a bias assessment. Registration with Prospero, International Registrar for Systematic Reviews, compliance with PRISMA, Transparent Reporting of Systematic Reviews and Meta-Analyses, guidelines, as well as being the only registered systematic review investigating the topic of mobile phone delivered behavioral intervention. Additionally, our systematic review gives a good indication of what successful interventions entail as it is was conducted systematically in nature (i.e., not a narrative review).

## **Conclusions**

Mobile phone-delivered interventions may be a promising method for decreasing SSB consumption. Studies which employ multiple methods of technology or modes of communication via a mobile phone saw greater reduction of SSB consumption in participants. Therefore, technologically-based interventions targeting SSB reduction should consider utilizing multiple forms of mobile-phone contact methods (i.e., phone call, text, email, social media, etc.) as they may be associated with greater effectiveness for improving SSB outcomes. Though the majority of trials demonstrated a beneficial impact of mobile phone-delivered beverage technology-based interventions aimed at improving beverage consumption patterns, there remains a need for additional rigorous trials with larger sample sizes across multiple ages and cultural populations with subgroup analyses to further develop the behavioral intervention science related to human diet. Future research should identify the best intervention methods for targeting specific behavioral outcomes. Nevertheless, given the increasing uptake of mobile technologies, the use of mobile health technologies may be a promising means to improve existing practices and interventions. This research should be approached with urgency as mobile

technology may be an important tool to reduce the global burden on health care by providing more effective dietary behavior and nutritional management support.

## **Chapter 5: Online Social Networking Pilot Feasibility Trial to Improve Beverage Consumption Patterns: The Healthy Beverage Habits Pilot Trial**

### **Abstract**

**Background:** Poor beverage consumption habits pose significant health concerns. Delivering health behavior change interventions via social media is an emerging area of health research and may provide a promising way to minimize barriers for participation, as well as provide health information and online social support through social media networks. Social networking has been cited as an effective way to produce positive behavioral outcomes in adults, although thus far, there has been limited research conducted on online social support health behavior change delivered through Instagram.

**Objective:** The primary objective of the Healthy Beverage Habits pilot trial was to determine feasibility of an 8-week intervention with a 4-week maintenance period aimed at improving overall beverage consumption patterns with the use of Instagram.

**Methods:** The objective of this online pilot intervention was to improve Healthy Beverage Index (HBI) scores and to determine the feasibility of online social support. The Healthy Beverage Habits study was a randomized control pilot trial, with an 8-week intervention and 4-week maintenance period, in which Instagram message prompts were administered to the intervention group. Identical messages were delivered to an E-mail control group, removing Instagram mediated online social support. Data analysis included descriptive statistics and repeated measures analysis of variance (RM-ANOVA) to test for differences in SSB, water, total beverage calories, and total fluid ounce intake via the Healthy Beverage Index (HBI) over the course of the 8-week intervention and 4-week maintenance periods.

**Results:** The study retention rate was 38%, with 39 participants initially enrolled and 15 participants completing all study visits through maintenance. No significant between group over time differences were found. However, the Instagram group demonstrated a significant reduction in total beverage kcal (mean difference $\pm$ SE=107.9 $\pm$ 48.3; p=0.049), and increase in total HBI scores (mean difference $\pm$ SE= 4.52 $\pm$ 2.26; p=0.025) from baseline to the end of the maintenance period. No within group differences were demonstrated for the E-mail control group over the intervention or maintenance period.

**Conclusions:** Instagram-based interventions may be a feasible means of improving beverage intake. More rigorous trials that determine what parts of the technology or intervention component was most feasible are necessary for further evaluation of mobile-delivered beverage consumption interventions.

**Keywords:** social networks; worksite wellness; beverage patterns; beverage consumption; sugar-sweetened beverages

## Introduction

The development of new and creative strategies such as social media-driven interventions may be beneficial for health promotion and social networking related to health. These types of social networking platforms require further investigation for their role in health behavior interventions. Specifically, social media networking websites and applications, such as Facebook<sup>136-138</sup> and Instagram,<sup>108,139</sup> have been cited as effective channels to encourage positive behavioral outcomes as part of digital health interventions (DHI). Multiple studies have reported benefits to using technology to enhance interventions for smoking cessation, diabetes management,<sup>122</sup> physical activity,<sup>123</sup> and weight loss.<sup>124</sup> Engagement with Twitter and Facebook support groups has also been significantly associated with weight loss.<sup>136-138</sup> For example, research has shown that participants involved in lifestyle interventions for obesity often achieve greater weight loss results in groups than individually.<sup>20-23</sup> For the purpose of this study, an online community will be defined as a group of people with a common interest or a shared purpose and who use social media and their networking systems to mediate social interaction while simultaneously facilitating a sense of togetherness.<sup>272</sup>

On a larger scale, social-media delivered behavioral interventions administered through employees' workplaces may be the most practical, accessible, and reliable mode of delivery. Being available 24/7 helps to ensure participants have access and can engage at their own leisure while creating a community of employees may help to boost participation. Moreover, given the rise in people working from home and in the overall increase of social distancing, the ability to be a part of an intervention without having to leave the comfort and safety of one's home may be a promising avenue of research to consider.<sup>139</sup>

With the current literature showing how worksite health promotion programs (WHP) have seen great success in reducing healthcare costs<sup>188</sup> and improving lifestyle behaviors such as poor diet and lack of physical activity,<sup>189</sup> the natural incorporation between WHP and DHI to improve health behavior may be a valuable way for behavioral health researchers to have the ability to widely disseminate health education while gathering data and monitoring employee engagement simultaneously.

With more than 60% of Americans' health insurance coverage coming from an employment-based plan,<sup>94</sup> the workplace is unique in that it presents a convenient setting for the introduction and maintenance of health-promotion programs for adults. WHP programs have common goals of promoting and maintaining good health behaviors and encouraging positive health behavior change.<sup>86</sup> WHP programs are becoming increasingly more popular and have been showcased in health reform proposals, the popular press, and congressional hearings.<sup>86</sup>

Today, the majority of American adults (~95%) own a cellphone of some kind and 77% own smartphones or phones with internet capabilities.<sup>29</sup> Mobile phone use covers a wide range of demographic groups, especially age.<sup>29</sup> Although, the use of smartphones is greater in Millennials (1981-1996) and Generation Xers (born 1965-1980) at 92% and 85% respectively, nearly 67% of Baby Boomers (born 1946-1964) and 30% of those in the Silent Generation (born 1928-1945) operate smartphones.<sup>29</sup>

To date, there have been relatively few studies carried out to determine the effects of the social media networking platform, Instagram, on health behavior change.<sup>139</sup> Specifically, there have been no known studies to date that have evaluated changes in beverage consumption habits within the context of an Instagram-based WHP. Worksite health and wellness programs might be a useful tool to target sections of the population that would be difficult to recruit and typically

not engage in community wellness programs.<sup>43</sup> In addition to SSB consumers having a strong association to certain metabolic and cardiovascular conditions, living in a rural community has also been associated with the consumption of more than three cans of SSB per day, considerably higher than that of the national recommend intake levels.<sup>12</sup> Specifically in Appalachia, adults consume three times more daily SSB calories as compared to the national average<sup>13,14</sup> making this population ideal for targeted behavioral interventions aimed at reducing SSB consumption.

A recent review by Hedrick et al., provided strong evidence that specific beverage patterns are associated with specific dietary patterns.<sup>273</sup> For example, someone with a healthy or prudent dietary pattern is more likely to consume water, unsweetened tea or coffee, low-fat milk, artificially sweetened beverages (non-nutritive sweeteners, NNS), and fruit or vegetable juices.<sup>273</sup> Conversely, a strong association between a Western dietary pattern and the consumption of high-fat milk, alcohol, and sugar-sweetened beverages (SSB) was found.<sup>273</sup> High SSB consumption has been linked to many health risks, such as obesity,<sup>4,5</sup> cardiovascular disease,<sup>5</sup> and diabetes.<sup>6-8</sup> SSB are highly consumed,<sup>274</sup> and high consumption of SSB is especially concerning for health disparate groups, including rural adults,<sup>275</sup> as rurality status has been associated with an increased likelihood of consuming more than three cans of SSB per day. This number is considerably higher than the national recommended intake level.<sup>276,277</sup> With the majority of chronic diseases associated with high SSB also being disproportionately high in rural areas,<sup>278-280</sup> developing strategies to reduce SSB intake and improve overall beverage intake through low-burden intervention strategies could be a promising way to mediate positive health behavior change.

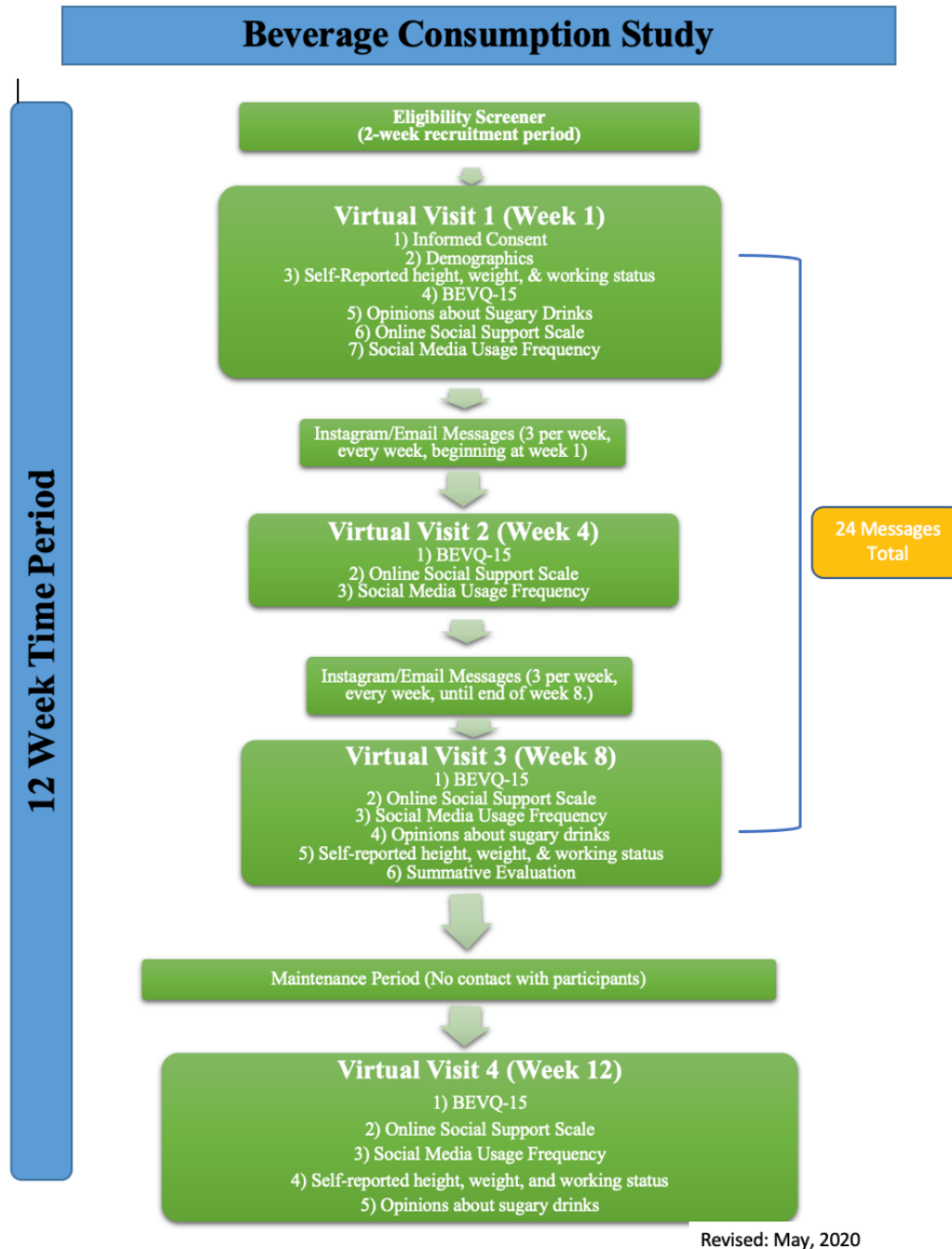
Worksite health and wellness programs might be a useful tool to target sections of the population that would be difficult to recruit and typically not engage in community wellness

programs,<sup>43</sup> especially those living in rural areas, such as the Appalachian region of southwest Virginia.<sup>13,14</sup> Thus, the primary objective of this WHP program pilot study was to determine the feasibility of an eight-week Instagram-delivered DHI, with a four-week maintenance period, aimed at improving overall beverage consumption patterns in Virginia Tech employees living in southwest Virginia, as compared to a matched-content E-mail control group.

## **Materials and Methods**

### ***Study Design***

This 8-week randomized controlled pilot study, the “Healthy Beverage Habits” trial, employed pre- and post-outcome data and repeated-measures process data. All study aspects were conducted virtually. Participants were randomized into either the Instagram-delivered social media arm or a non-social media matched-content E-mail control group. A 4-week maintenance period of no contact from researchers followed the intervention in order to monitor for sustainability of changes post intervention. Instagram message prompts were administered to the Instagram intervention group targeting improvement in beverage consumption, specifically by decreasing SSB intake and increasing consumption of water. Identical messages were delivered to the E-mail control group, essentially removing the aspect of online social support. See **Figure 1** for a detailed study flow chart.



**Figure 1.** Study Flow Chart for the Healthy Beverage Habits Trial

### ***Study Participants***

All interested Virginia Tech employees were asked to complete an initial screening survey to ensure that they were at least 18 years or older, had internet access, and consumed 8 fluid ounces or more of SSB per day to be eligible to participate. SSB consumption was assessed through the BEVQ-15 which is described below. Participants also had to be willing to download the Instagram mobile application (i.e., must own or operate a phone capable of downloading mobile applications) and participate with all study protocols, including compliance with Instagram's terms of use. Participants for this pilot intervention were recruited via Hokie Wellness and Virginia Tech Graduate Student listservs, as well as postings to Hokie News. Hokie Wellness is Virginia Tech's onsite wellness program. The department offers work/life resources, health and wellness programs, and collaborations with many academic and community partners to help enhance the health and wellness of all Hokies. Programs covering a variety of health and wellness topics are available for all employees and students. Additionally, snowballing recruitment methods were employed via all those who expressed interest in participating in the study.

### ***Intervention Development and Content***

The current investigation is based on the SIPsmartER trial whose primary trial aim was to determine the feasibility of a health behavior intervention on reducing SSB intake compared to a matched-contact comparison group.<sup>281</sup> The multicomponent intervention was guided by the Theory of Planned Behavior (TPB),<sup>166,167</sup> health literacy concepts,<sup>282</sup> and the RE-AIM evaluation framework.<sup>283</sup> The TPB is a commonly used theory for predicting and understanding health behaviors and has been applied to a wide variety of health contexts, including dietary behaviors.<sup>166,167</sup> RE-AIM (Reach, Effectiveness, Adoption, Implementation, and Maintenance)

includes concepts related to the intervention's structure (e.g., barriers to participation), delivery platform (e.g., how to administer the intervention content to participants), and study design (e.g., includes the underlying behavioral change theory), and content (e.g., evidence-based).

SIPsmartER content was modified for a virtual delivery via either Instagram or E-mail of the "Healthy Beverage Habits" trial.

Instagram is a free social networking application that was made for sharing photos and videos online. Using a hashtag helps others who are interested in a certain topic, quickly find content on that same topic. By using the study's assigned hashtag on a photo or video, it allows others to view that image. Participants randomized to the Instagram intervention group received an Instagram usage guide via email, were required to sign-up for a "public" Instagram account, and also follow the intervention's Instagram account, @HealthyBeverageHabitsVT, and hashtag, #HealthyBeverageHabitsVT.

Over the 8-week period, both the Instagram intervention group and E-mail control group participants received three messages per week for a total number of 24 prompt message posts over the entire 8-week intervention period (**Table 1**). Researchers choose three messages per week in order to keep participants engaged, yet not overwhelm them with information which might result in intervention fatigue.<sup>284</sup> Intervention messages, including structure, theoretical constructs, objects, and content, were adapted from SIPsmartER Lesson 1 (**Appendix E**).

The Instagram group received prompt message posts delivered through Instagram, while those in the E-mail control group received prompt messages in E-mail form with a link to a Qualtrics survey to track participant views and therefore removing social media networking and community dynamics from those participants randomly assigned to the E-mail control group.

Instagram message “like” data and comments were recorded for each participant within the Instagram group.

**Table 1.** Description of Intervention Material Type

Material Type	Number of Messages	Purpose	Content
Prompt Message	8	To provide participants with a prompt to complete activities	Motivation for overcoming common barriers to drinking fewer sugary drinks
Information Message	16	To provide participants with a reference	Strategies for overcoming common barriers to drinking fewer sugary drinks

### *Data Collection Tools*

A detailed overview of the timepoints at which each measurement tool was administered to participants can be seen in **Table 2**.

**Table 2.** Measures Overview for the Healthy Beverage Habits Trial.

Measure (tool)	Baseline	4-Weeks	8-Weeks	12-Weeks
Demographic Questions	X	X	X	X
Anthropometrics (Height and Weight)	X		X	X
Beverage Intake (BEVQ-15)	X	X	X	X
Online Social Support Scale (OSSS) <sup>285</sup>	X	X	X	X
Social Media Usage Frequency	X	X	X	X
Summative Evaluation			X	

### *Demographic and Anthropometric Data*

Demographic information was collected in the form of an online Qualtrics survey administered during baseline for age, sex, ethnicity/race, and highest education level completed. Additional information, including self-reported anthropometrics (height and weight), data on employee type, if they were working from home due to COVID-19, and if they had any recent changes to their health was collected during all timepoints.

### *Beverage Consumption*

The online version of the BEVQ-15, developed at Virginia Tech, provides an online, easy to access tool for users to assess and track beverage consumption patterns, and has applicability

as a tool for individuals, research purposes, or clinical settings. The beverage consumption questionnaire (BEVQ-15 online version) was completed at each time point.<sup>286</sup> The BEVQ-15 is able to measure habitual beverage consumption in fluid ounces and calories for specific beverages, total SSB, and total beverages over the past month. The online BEVQ-15 can be accessed at <https://shark.cs.vt.edu/BevQ/> and is a cloud-based software, meaning it is web-based and therefore can be accessed through any internet capable device. Therefore, users can choose to complete the online version on their computers, tablets, and phones. Before completing the questionnaire, participants were asked to set up an account through the website.

After account creation, users then completed the online BEVQ-15. Each of the 15 beverage categories displays a visual representation of each beverage type and prompts users to answer both “how often” and “how much each time” a specific beverage was consumed over the past month. For beverages that not listed within the 15 beverage categories, an “other” category is available for users to include less commonly consumed beverages (e.g., kefir, kombucha, coconut water, etc.). The accordion-style format allows users to easily complete the questionnaire on smaller screens and without having to scroll down the page. Furthermore, the online BEVQ-15 requires users to answer both questions for all beverage category before the questionnaire can be submitted, reducing the issue of missed questions. At the completion of 8-weeks and 12-week maintenance periods, participants were asked to download their BEVQ-15 output files and submit them to researchers via email attachment.

The BEVQ-15 gathered beverage data that was used to provide Healthy Beverage Index (HBI) scores. The HBI serves as a measure of overall beverage quality in an individual and helps to evaluate “the extent to which an individual’s beverage intake meets recommendations.”<sup>287</sup> HBI total score ranges from 1 to 100, with higher scores indicating a healthier beverage score

(i.e., low consumption of SSB, adequate water intake, etc.). HBI scores were calculated using BEVQ-15 data and analyzed according to HBI published protocol.<sup>48</sup>

### ***Social Media Usage Frequency and Online Social Support***

A brief survey of social media usage frequency information was completed at baseline, midpoint, and at the end of the 8-week intervention pilot study and again at the 12-week maintenance period (**Appendix F**). The Online Social Support Scale (OSSS)<sup>285</sup>, used to assess online social support within both groups, was also completed at all timepoints (**Appendix G**).

### ***Summative Evaluation***

A summative evaluation was conducted at 8-weeks, i.e., the end of the intervention period, in order to better understand participants' experience and overall satisfaction with the intervention. Participants were asked a short series of open-ended questions after the completion of all other study surveys. Surveys differed slightly between the two groups with the Instagram social media group receiving additional questions pertaining to Instagram delivery and posting specifically (**Appendix H**).

### ***Statistical Analysis***

Descriptive statistics, including means, standard deviations, and frequencies were reported. Differences in variables were assessed via independent t-tests and chi-square analyses. In order to assess changes in SSB, water, total beverage calories, and total fluid ounce intake over the course of the 8-week intervention pilot trial and 4-week maintenance, repeated measures analyses of variance (RM-ANOVA) were performed within and between groups. Tukey's post hoc tests were utilized for the 4-timepoints (baseline/week 1, week 4, week 8, and week 12) between the Instagram intervention group and E-mail control group. Correlation analyses were

performed using Spearman's  $r$  for Instagram usage and Instagram participation versus timepoint, HBI score, total beverage intake, total SSB intake, and OSSS.

Demographics of participants, specifically those who signed up for the intervention pilot study versus the average demographics for Virginia Tech employees, were conducted through the use of a Reach assessment. Reach is the first step of RE-AIM. Reach and representativeness were analyzed following the recommendations of Glasgow and colleagues.<sup>283</sup> For reach, the number exposed to recruitment activities was estimated and participation rate was calculated by dividing the total number of participants enrolled by the total number of Virginia Tech employees. To examine representativeness of the enrolled sample, the sample's demographics were compared to demographics of the targeted population via descriptive statistics (means, frequencies).

Quantitative statistical analyses were performed using SPSS statistical analysis software, version 26.0. Significance was determined using a P-value  $\leq 0.05$ . Participants that completed all data collection points were included in the final analytical sample.

Qualitative data was transcribed from participant's open-ended questions administered during the Summative Evaluations of the Healthy Beverage Habits intervention via Qualtrics, coded (i.e., words or phrases with a single meaning), and organized into overarching themes.<sup>288</sup> Inductive coding methods were applied in order to observe what key themes naturally arose based on collected data. Inductive coding refers to the type of data analysis process whereby the researcher reads through and interprets the raw textual data to develop concepts, themes or a process model through their interpretations based on the qualitative data.<sup>289</sup>

### ***IRB Approval and Consent***

The study received approval by the Virginia Tech Institutional Review Board for IRB 20-237. Prior to any study activities and upon initial interest email, participants were emailed VT IRB-stamped informed consent documents (**Appendix I**). At Virtual Visit 1, the statement, “Completion of all online study surveys and/or questionnaires implies consent” was clearly posted along with the study’s IRB-stamped informed consent document. Implied consent is most common in minimal risk research that involves the completion of surveys and questionnaires. By responding to the questions or hitting the submit button, participants agreed to participate in the research. Participants, if part of the intervention group, had to privately consent to Instagram’s Terms of Use Agreement.

### ***Compensation***

Upon completion of all 4 Virtual Visits, participants of the pilot intervention were entered to win a drawing for a 1 in 10 chance of winning a \$50 Visa gift card.

## **Results**

### ***Reach and Representativeness and Demographics***

This intervention targeted Virginia Tech employees and graduate students. Based on data reported by Virginia Tech, there was approximately 2,168 faculty, 1,521 graduate students, and approximately 3,500 staff members for a total target population of 7,189. The two main methods of contact through E-mail, Hokie Wellness (approximately 4,000 faculty and staff) and the Graduate Student Newsletter (1,521 graduate assistants). The third method of contact, the Virginia Tech News, is sent to all Virginia Tech employees and students, also via E-mail (contact list unknown). Therefore, the total confirmed to be contacted via the Hokie Wellness and Graduate Student Newsletters was 5,521. The reach of the recruitment was calculated at

76.8%, using the total number exposed to recruitment, 5,521, as the numerator while the total population, 7,189, was set as the denominator.

One hundred and seven individuals responded to recruitment emails, representing 1.5% of the targeted population (107/7,189). Of the 107 who originally responded to recruitment, 12 interested individuals or 11.2% dropped out of the study citing “not willing to use Instagram” as the main barrier for participation (demographic data was not available for these participants). An additional 56 interested individuals were excluded due to not meeting remaining inclusion criteria after initial screening for minimum SSB consumption, Virginia Tech employment status, and willingness to use Instagram. This left 39 individuals eligible, or 36.4% of those who originally expressed interest in participation. These 39 individuals were used as the numerator to calculate a total study reach of 0.5%, using the total target population as the denominator (39/7,189). This left study retention at 38% from baseline to end of maintenance period. The timeline of participant retention can be seen in **Table 3**.

**Table 3.** Participant Retention Timeline

<b>Initial Recruitment</b>		<b>Randomization</b>		<b>Intervention</b>			<b>Maintenance</b>
<b>Screened n</b>	<b>Eligible n (%)</b>	<b>Group</b>	<b>Randomized n (%)</b>	<b>Baseline n (%)</b>	<b>4-Week n (%)</b>	<b>8-Week n (%)</b>	<b>12-Week n (%)</b>
<b>107</b>	<b>39 (36)</b>	<b>Instagram</b>	18 (46)	10 (55)	8 (80)	10 (100)	6 (60)
		<b>E-mail</b>	21 (54)	14 (67)	14 (100)	11 (79)	9 (64)

Pilot study demographic differences between enrolled and completers found no significant difference for any demographic category (**Table 4**).

**Table 4.** Pilot Study Demographic Differences Between Enrolled and Completers

Characteristics	Enrolled n (%)	Completers n (%)	Statistic (P-Value) <sup>b</sup>
Total (n)	39	15	
Age, years; Mean (SD)	40.6 (11.6)	41.1 (9.6)	0.202
Sex			0.687
Male	6 (15.4)	2 (13.3)	
Female	26 (66.7)	11 (73.3)	
Prefer Not to Answer	7 (17.9)	2 (13.3)	
Race			0.341
White, not of Hispanic origin	30 (76.9)	12 (80.0)	
Black, not of Hispanic origin	1 (2.6)	1 (6.7)	
Hispanic/Latino	1 (2.6)	0 (0.0)	
Asian	0 (0.0)	0 (0.0)	
Prefer Not to Answer	7 (17.9)	2 (13.3)	
Highest Grade Completed			0.219
Some college	1 (2.6)	3 (20.0)	
College graduate	12 (30.8)	10 (66.7)	
Post college work	19 (48.7)	13 (86.7)	
Prefer Not to Answer	7 (17.9)	2 (13.3)	
Employee Type			0.068
Staff	13 (33.3)	3 (20.0)	
Faculty	17 (43.6)	10 (66.7)	
Paid Graduate Student	2 (5.1)	0 (0.0)	
Prefer Not to Answer	7 (17.9)	2 (3.3)	
Body Mass Index (BMI), kg/m <sup>2</sup>			0.472
Underweight ( $\leq 18.4$ )	0 (0.0)	0 (0.0)	
Normal weight (18.5-24.9)	12 (30.8)	5 (33.3)	
Overweight (25-29.9)	8 (20.5)	3 (20.0)	
Obese ( $\geq 30$ )	12 (30.8)	5 (33.3)	
Prefer Not to Answer	7 (17.9)	2 (13.3)	
<sup>a</sup> Values are n (%) unless otherwise noted. <sup>b</sup> Differences between groups for categorical variables were compared using $\chi^2$ .			

Eligible participants were randomly assigned to receive the intervention through Instagram (n=18) or E-mail (n=21). Of those thirty-nine individuals, twenty-four completed all baseline questionnaires (Instagram n=10, E-mail n=14), and began the intervention. Fifteen participants completed the maintenance data collection (Instagram n=6, E-mail n=9), data from those completing participants were used to assess intervention feasibility and reported.

Virginia Tech Faculty ethnic diversity consists of 75.5% White, 11.6% Asian, 3.4% Hispanic/Latino, and 3.3% Black or African American.<sup>290</sup> Our sample consisted of 86% White and 7% Black. Male to female breakdown of faculty at Virginia Tech is equally balanced at 49.9% male and 50.1% female. Our sample identified as 14% male and 79% female. Therefore, the representativeness of our sample as compared to the whole faculty population of Virginia Tech is less diverse and less evenly distributed on the basis of gender. Participant demographics can be found in **Table 5**. Demographic data was not obtained from one participant in the E-mail control group. Groups did not differ for any demographic category at baseline (**Table 6**).

**Table 5.** Baseline Demographics for Instagram-delivered social media and E-mail control groups for the Healthy Beverage Habits Trial

Characteristics	Instagram (n=6) n (%) <sup>a</sup>			E-mail (n=9) n (%) <sup>a</sup>				Statistic (P-Value) <sup>b</sup>
Age, years; Mean (SD)	42 (13)			40 (7)				0.762
Sex								0.014
Male	1 (16.7)			1 (11.1)				
Female	5 (83.3)			6 (66.7)				
Prefer Not to Answer	0 (0.0)			2 (22.2)				
Race								1.264
White, not of Hispanic origin	5 (83.3)			7 (77.8)				
Black, not of Hispanic origin	1 (16.7)			0 (0.0)				
Prefer Not to Answer	0 (0.0)			2 (22.2)				
Highest Grade Completed								4.550
Some college	0 (0.0)			0 (0.0)				
College graduate	3 (50.0)			0 (0.0)				
Post college work	3 (50.0)			7 (77.8)				
Prefer Not to Answer	0 (0.0)			2 (22.2)				
Employee Type								0.660
Staff	2 (33.3)			1 (11.1)				
Faculty	4 (66.7)			6 (66.7)				
Paid Graduate Student	0 (0.0)			0 (0.0)				
Prefer Not to Answer	0 (0.0)			2 (22.2)				
Working from home due to COVID-19?	Yes	No	Sometimes	Yes	No	Sometimes	No Answer	
Baseline	4 (66.7)	1 (16.7)	1 (16.7)	4 (44.4)	2 (22.2)	1 (11.1)	2 (22.2)	0.258
8-Weeks	4 (66.7)	1 (16.7)	1 (16.7)	3 (33.3)	2 (22.2)	2 (22.2)	2 (22.2)	0.737
12-Week Maintenance	3 (50.0)	1 (16.7)	2 (33.3)	2 (22.2)	2 (22.2)	2 (22.2)	3 (33.3)	0.533
Body Mass Index (BMI), kg/m <sup>2</sup>								2.270
Underweight (≤18.4)	0 (0.0)			0 (0.0)				
Normal weight (18.5-24.9)	3 (50.0)			2 (22.2)				
Overweight (25-29.9)	2 (33.3)			1 (11.1)				
Obese (≥30)	1 (16.7)			4 (44.4)				
Prefer Not to Answer	0 (0.0)			2 (22.2)				
<sup>a</sup> Values are n (%) unless otherwise noted. <sup>b</sup> Differences between groups for age was compared using an ANOVA. Differences between groups for categorical variables were compared using $\chi^2$ .								

### *Effect of Healthy Beverage Habits Pilot Study on Beverage Consumption*

Throughout the length of the Healthy Beverage Habits pilot study, there was a significant reduction in total SSB (kcal) consumption (mean difference $\pm$ SE= -105 $\pm$ 44; p=0.025) among all participants independent of delivery method, as indicated by a time effect (**Figure 1**). This was reflected in total beverage energy HBI scores which increased throughout the intervention among all participants (mean difference $\pm$ SE= 4.6 $\pm$ 1.6; p=0.049) (**Figure 2**).

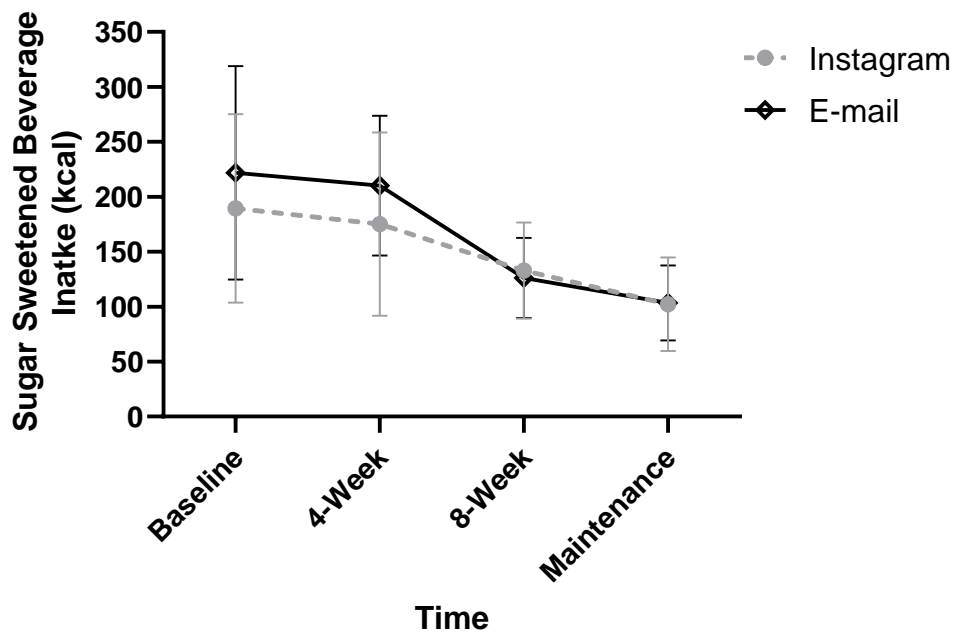


Figure 1. Changes in sugar-sweetened beverage (SSB) intake between an Instagram group and E-mail group over and 8-week intervention and 4-week maintenance period aimed at improving beverage consumption\*

\*A significant time effect reduction in SSB (kcal) consumption among all participants was demonstrated (p=0.025), independent of intervention group.

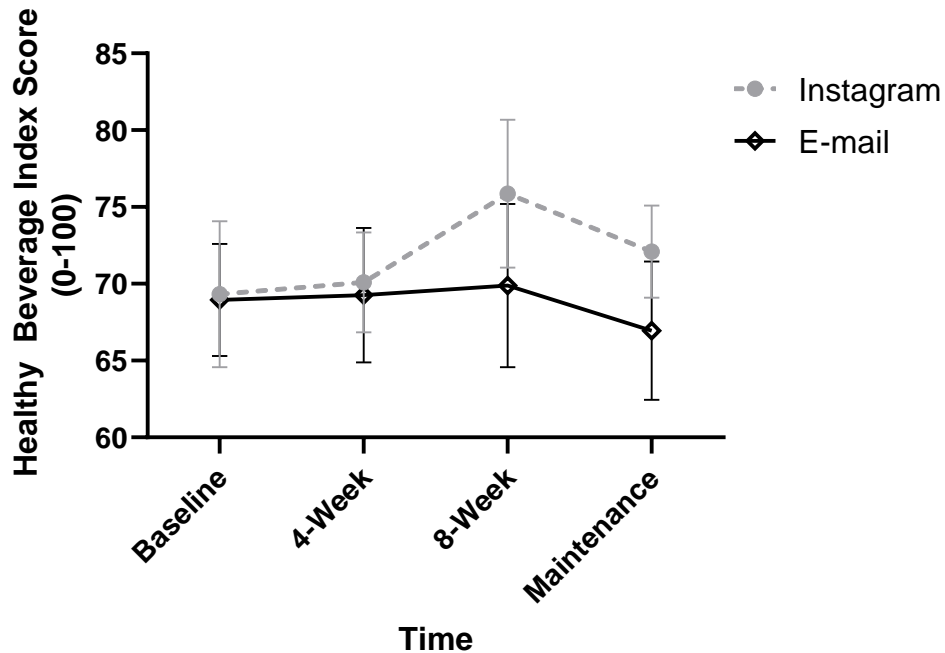


Figure 2. Changes in Healthy Beverage Index (HBI) Score between an Instagram group and E-mail group over and 8-week intervention and 4-week maintenance period aimed at improving beverage consumption\*

\*A significant time effect improvement in HBI scores among all participants was demonstrated ( $p=0.049$ ), independent of intervention group.

When comparing between delivery method groups there were no differences detected between the Instagram and E-mail groups for beverage consumption categories at baseline nor any other time point. There were no interaction effects detected for any beverage intake category. A post hoc analysis revealed a decrease in total beverage calories (mean difference $\pm$ SE= -156 $\pm$ 48;  $p=0.049$ ), and an increase in total HBI score (mean difference $\pm$ SE= 11.9 $\pm$ 2.3;  $p=0.025$ ) in the Instagram group from baseline to maintenance assessment. These group changes were not detected in the E-mail group. Beverage consumption data can be seen in **Table 6**.

**Table 6.** Beverage Consumption Data Through Intervention and Maintenance Periods by Treatment Group for the Healthy Beverage Habits Trial.

<b>Beverages</b>	<b>Group</b>	<b>Baseline M (SD)</b>	<b>4-Weeks M (SD)</b>	<b>8-Weeks M (SD)</b>	<b>12-Weeks Maintenance M (SD)</b>	<b>Interaction F Statistic (P-value)<sup>a</sup></b>
<i>Total Sugar-Sweetened Beverages (fl oz)</i>	Instagram	18.1 (17.8)	19.0 (21.5)	26.8 (36.5)	10.8 (12.6)	0.33 (0.81)
	Email	18.8 (21.4)	20.6 (19.3)	20.4 (32.8)	12.09 (10.8)	
<i>Total Sugar-Sweetened Beverages (kcal)</i>	Instagram	189 (210)	175 (204)	133 (108)	102 (105)	0.20 (0.90)
	Email	222 (275)	210 (180)	126 (104)	103 (96)	
<i>Total Water (fl oz)</i>	Instagram	43.3 (33.4)	33.5 (19.6)	38.14 (13.8)	46.0 (35.6)	0.91 (0.45)
	Email	38.7 (24.1)	40.0 (25.0)	34.18 (22.3)	33.9 (19.0)	
<i>Total Beverage Calories (kcal)</i>	Instagram	383 (240)	301 (230)	230 (97)	226 (140) <sup>b</sup>	0.97 (0.42)
	Email	663 (926)	660 (857)	411 (471)	268 (285)	
<i>Total Fluid Consumption (fl oz)</i>	Instagram	79.6 (29.8)	76.0 (35.5)	74.7 (28.0)	68.5 (34.6)	0.77 (0.52)
	Email	77.1 (44.3)	83.5 (44.4)	64.5 (39.7)	59.6 (35.2)	
<i>SSB HBI Score</i>	Instagram	3.0 (6.3)	3.8 (6.9)	6.0 (7.8)	5.0 (7.8)	0.42 (0.71)
	Email	3.2 (6.4)	4.3 (7.0)	6.8 (7.8)	3.3 (6.6)	
<i>Water HBI Score</i>	Instagram	13.9 (3.5)	14.15 (2.4)	15.0 (0.0)	14.9 (0.3)	1.06 (0.38)
	Email	14.0 (3.1)	14.0 (3.1)	12.9 (4.0)	13.9 (3.4)	
<i>Total Beverage Energy HBI Score</i>	Instagram	8.3 (9.6)	10.0 (8.8)	9.5 (9.6)	8.6 (7.0)	1.42 (0.26)
	Email	8.5 (9.5)	8.4 (9.6)	10.4 (9.1)	9.5 (8.9)	
<i>Total Fluid Requirements HBI Score</i>	Instagram	19.2 (2.1)	16.6 (5.9)	18.3 (3.5)	17.8 (3.7)	1.72 (0.19)
	Email	18.2 (3.5)	18.3 (3.4)	16.2 (4.7)	16.4 (5.8)	
<i>Total HBI Score</i>	Instagram	68.3 (17.0)	68.8 (21.8)	76.4 (18.6)	74.4 (16.6) <sup>b</sup>	1.22 (0.32)
	Email	62.4 (9.6)	62.7 (8.3)	61.4 (15.1)	67.6 (7.4)	

Instagram n=6, E-mail n=9

<sup>a</sup>Assessed via repeated measures ANOVA = RM-ANOVA

<sup>b</sup>Significant change from baseline within a delivery group determined by Tukey post hoc analysis, p<0.05

SSB= Sugar-Sweetened Beverage

HBI= Healthy Beverage Index



### *Social Media Usage Changes Over Time Between Instagram and E-mail Groups*

Results from online social support and social media questionnaires can be seen in **Table 7**. Baseline values of social media usage did not differ between groups. Social media frequency and online social support were rated on a scale of “1” to “7” by participants with “1” indicating low levels of social media usage or online social support and “7” indicating high levels of social media usage or high levels of online social support. Total Instagram participation did not correlate with average social media usage (average reported use of all social media platforms,  $r=0.376$ ,  $p=0.229$ ). Total Instagram participation did correlate negatively with participant reported Instagram usage at baseline ( $r=-0.658$ ,  $p=0.023$ ), 4-weeks ( $r=-0.857$ ,  $p=0.003$ ), and 8-weeks ( $r=-0.707$ ,  $p=0.013$ ), but was not significant at maintenance ( $r=-0.682$ ,  $p=0.053$ ). A negative correlation was also detected between total Instagram participation and participants overall OSSS scores ( $r=-0.8727$ ,  $p=0.016$ ), indicating those who were more active during the intervention had lower perceived online social support. Self-reported Instagram use in the Instagram delivery group was influenced by the intervention as indicated by the significant interaction effect ( $p<0.01$ ). The detected interaction effect was most likely due to an increase in self-reported Instagram usage in the Instagram group from baseline to 4-weeks ( $1.43\pm 1.4$  vs  $2.71\pm 0.76$ ) however, this change was not significant ( $p=0.067$ ). Self-reported Instagram use did not differ between the Instagram and E-mail groups ( $p=0.83$ ).

**Table 7.** BMI, Social Media Frequency, and Online Social Support Responses by Treatment Group for the Healthy Beverage Habits Trial.

Measure	Group	Baseline M (SD)	4-Weeks M (SD)	8-Weeks M (SD)	12-Weeks Maintenance M (SD)	Interaction F Statistic (P-value) <sup>a</sup>
<i>BMI</i>	Instagram	26.62 (3.44)	26 (3.29)	25.94 (3.25)	26.11 (3.83)	1.55 (0.22)
	E-mail	28.61 (6.98)	27.8 (7.11)	28.32 (6.6)	28.9 (6.53)	
<i>Social Media Frequency</i>	Instagram	0.61 (0.25)	0.73 (0.18)	0.66 (0.21)	0.71 (0.23)	1.81 (0.16)
	E-mail	0.74 (0.25)	0.72 (0.28)	0.62 (0.3)	0.68 (0.35)	
<i>Instagram Usage</i>	Instagram	1.43 (1.4)	2.71 (0.76)	2.14 (1.21)	2.00 (1.15)	5.59 (<0.01)*
	E-mail	2.00 (1.67)	1.82 (1.47)	1.82 (1.54)	2.09 (1.58)	
<i>OSSS- Online Social Support</i>	Instagram	1.21 (0.92)	1.1 (0.79)	1.18 (0.87)	1.21 (0.80)	0.37 (0.78)
	E-mail	1.63 (0.85)	1.66 (0.94)	1.56 (0.96)	1.59 (0.91)	

Instagram n=6, E-mail n=9

Social Media Frequency and OSSS (0=Never, 1=Rarely, 2=Sometimes, 3=Pretty Often, 4=A Lot)

<sup>a</sup>Assessed via repeated measures ANOVA = RM-ANOVA

\*Significant effect of p<0.05

BMI= Body Mass Index

### ***Instagram Delivery***

Total Instagram participation was calculated for the total of “likes” and comments” participants made on the posted prompts. Data for total Instagram participation can be seen in **Table 8**. Instagram participation decreased over time from the start of the intervention to the final prompt. Instagram activity (likes and comments) from participants throughout the intervention did not correlate to changes in main outcome measures of HBI score (r=-0.068, p=0.853), total beverage calories (r=-0.474, p=0.167), or total SSB caloric intake (r=-0.497, p=0.144).

**Table 8.** Instagram Social Media Group Prompt, Like, and Comment Participation Throughout the 8-Week Intervention.

Baseline	4-Week												8-Week								Pearson's correlation r (p)					
Week	1			2			3			4			5			6			7			8			Total	
Prompt	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		
Likes	6	3	3	4	2	6	4	2	4	2	4	4	3	3	4	2	3	4	2	2	3	2	2	2	76	-0.51 (0.01)
Comments	1	2	0	1	0	2	0	3	0	1	0	1	0	0	0	2	0	0	1	0	0	0	0	0	14	-0.40 (0.05)
Total	7	5	3	5	2	8	4	5	4	3	4	5	3	3	4	4	3	4	3	2	3	2	2	2	90	-0.63 (0.01)

Data collected from Instagram for intervention prompt messages (n=6 participants). Three message a week were delivered on Mondays, Wednesdays, and Fridays at 10 am for 8-weeks. Pearson's correlations were performed for prompt number vs likes, comments, and total activity (likes and comments).

***Thematic Analysis of Qualitative Themes***

Several positive themes from the Instagram Social Media group were found. Frequency of posts and constant reminders of healthy beverage habits were the most prevalent followed by information, convenience, activities, the images, and the Instagram platform itself. Alternatively, key themes related to participants' dislike of the intervention included the overall tone of the messages, message content, missed or didn't see messages, lack of interaction or personalization, and lengthiness of content. When asked about barriers to making posts, themes such as only using Instagram to follow other accounts, rarely/never makes posts, content consistency, unsure of expectations, and time constraints were cited. Thematic Data from the Instagram Social Media group can be found in **Table 9**.

<b>Table 9.</b> Instagram Social Media Group Qualitative Thematic Data
Instagram Social Media Group Positive Themes
<p><i>“It got me to think about my habits and how I could improve and make better choices.”</i></p> <p><i>“Gives you reminders while scrolling through [Instagram].”</i></p> <p><i>“Reminders to be healthy, quiz type activities.”</i></p> <p><i>“I was brand new to Instagram so it was a new tool and I liked it.”</i></p> <p><i>“Images”</i></p> <p><i>“I liked the helpful reminders that would pop up when scrolling”</i></p> <p><i>“Easy to find.”</i></p> <p><i>“It gave me motivational reminders.”</i></p> <p><i>“Activities made you think about what you drink and what could be used to substitute.”</i></p> <p><i>“It was very informative.”</i></p> <p><i>“Some interesting information.”</i></p> <p><i>“I liked the reminders.”</i></p> <p><i>“Frequency of posts.”</i></p>
Instagram Social Media Group Negative Themes
<p><i>“It felt a little preachy at times.”</i></p> <p><i>“Feels like a sales pitch at times.”</i></p> <p><i>“Posts were a little long, images were too generic or didn't get my attention.”</i></p> <p><i>“I think I didn't see a few of them due to Instagram algorithm.”</i></p> <p><i>“[I] felt there could have been more posts and possibly more interactive.”</i></p> <p><i>“It should have tagged me or posted stories with questions.”</i></p> <p><i>“Didn't know how the overall program was organized.”</i></p> <p><i>“I didn't see a few of them.”</i></p>
Barriers to making posts
<p><i>“Consistency with my content. If I would post about sugary drinks out of the blue, I feel like that's not why people follow me, and would look like my account got hacked.”</i></p> <p><i>“I don't post a lot on Instagram. Mainly use it to follow other accounts.”</i></p> <p><i>“I rarely post on any social media.”</i></p> <p><i>“I wasn't sure what the expectation was, but I did make some posts.”</i></p> <p><i>“Time.”</i></p>

Participants in the E-mail/Control group mentioned enjoying the constant reminders and reinforcement they received through the intervention. Length of messages, activities, and ease of engagement were additionally mentioned as reasons for liking the intervention. Conversely, participants also disliked the lack of “new” information presented, the impersonal tone, length,

number of messages, and non-interactive activities provided by the intervention. Thematic Data from the E-mail control group can be found in **Table 10**.

<b>Table 101.</b> E-mail Control Group Qualitative Thematic Data
<b>E-mail Control Group Positive Themes</b>
<p><i>“It was simple and the reminders were helpful without being obtrusive.”</i></p> <p><i>“Messages were short and surveys were relatively quick to fill out.”</i></p> <p><i>“It was consistent.”</i></p> <p><i>“The reminders were easy to digest.”</i></p> <p><i>“Insightful information; sometimes things I had forgotten I knew”</i></p> <p><i>“Nice to have a reminder of just how much sugar hides in drinks.”</i></p> <p><i>“Some of the reminders were helpful. It was quick and easy to do.”</i></p> <p><i>“I liked the tips for decreasing sugary beverage intake, especially keeping a log of intake.”</i></p> <p><i>“It was interesting to read and reinforce what I know”</i></p> <p><i>“Good length of messages.”</i></p> <p><i>“Info presented logically”</i></p> <p><i>“Online, easy to complete surveys and not too time consuming to participate.”</i></p> <p><i>it reminded me to drink more water which made me feel better.”</i></p> <p><i>“Ease of doing.”</i></p>
<b>E-mail Control Group Negative Themes</b>
<p><i>“I didn't really learn anything new that I didn't already know about sugary drinks. I didn't like the weight-shaming tone of some messages.”</i></p> <p><i>“There were just a lot of messages to get through. More than I thought.”</i></p> <p><i>“Some of the tips were plain common sense, so not really helpful. But they did make me think about it”</i></p> <p><i>“The reminders didn't feel personal”</i></p> <p><i>“It wasn't as interactive as I hoped. The messages seemed mundane after a while.”</i></p> <p><i>“The prompts seemed impersonal could have been more interactive.”</i></p> <p><i>“[Messages were] sometimes too long.”</i></p>

## Discussion

The primary aim of this study was to assess the feasibility of a digital beverage consumption pilot trial administered via Instagram and E-mail to Virginia Tech Employees to improve beverage intake patterns. In addition to the primary aim, the secondary aim was to gain a better understanding the contextual factors impacting reach, adoption, implementation, and maintenance, thus, the intervention applied the RE-AIM planning and evaluative framework.<sup>283</sup> Given that both the E-mail and Instagram groups received the exact same intervention materials,

all participants had the opportunity to benefit from participation, therefore, allowing for a comparison that is independent of participants' beverage consumption.<sup>288</sup>

The main findings from this study is that the SIPsmartER: Lesson 1 curriculum shows potential to be adapted for an online intervention targeting beverage consumption patterns. When all participants were combined into one group, i.e., regardless of delivery method, the pilot study was successful at reducing SSB (kcal) and improving total HBI scores. Although there were no significant between group over time difference, for within group changes, the Instagram group was able to significantly reduced total beverage kcals and significantly improved total HBI score, while the E-mail group did not demonstrate any significant changes in these measures. The original SIPsmartER program saw significant reductions in SSB (kcals) and BMI from baseline to 6-months as compared to a physical activity control group.<sup>291</sup> The effects of SIPsmartER on beverage consumption were similar to those seen in this Healthy Beverage Habits pilot study. Due to the shorter duration of this pilot trial, 8-weeks versus SIPsmartER's 6-month intervention period, changes in BMI were not expected.

Involvement in the Instagram delivery platform did not seem to dramatically alter participants social media activity. Participation in the Instagram intervention was evaluated through measured Instagram activity ("Likes" and "Comments") as well as self-reported Instagram use. Data collected on Instagram activity indicates participants were active and involved at the beginning of the intervention, but this activity decreased towards the conclusion of the intervention. This trend was also observed in self-reported Instagram use which in the Instagram group exhibited an increase (though not statistically significant) from baseline to the week-4 measure with activity then decreased as well. Though involvement in the Instagram delivery group did increase Instagram usage for participants there were no difference in

Instagram usage between the Instagram and E-mail groups overall. Nor were there any differences between groups for usage of other social media platforms (Facebook, Twitter, etc.)

Overall, this study highlights the feasibility of using Instagram as a tool for the delivery of health behavior interventions. The findings from this study are similar to previous health behavior interventions which used Instagram as a tool to improve physical activity,<sup>292-294</sup> healthy eating,<sup>295</sup> and gratitude.<sup>296</sup> Instagram, as an intervention delivery method, provides researchers with a convenient and accessible platform to communicate with participants through social media while simultaneously providing information to improve beverage consumption patterns and deserves further investigation.<sup>288</sup> As seen in the literature, interventions employing public health education and/or counselling on average see only small reductions in SSBs in adolescents and adults.<sup>297</sup> In contrast, the Instagram-delivered 4-week wellness intervention by Blackstone et al. (2020)<sup>298</sup> and meta-analysis findings by Williams, et al. (2014),<sup>299</sup> reported no significant impacts on health behavior change via Instagram. In recruitment for this study 12 interested individuals dropped out for not wanting to use the Instagram platform. This is understandable as similar studies looking to understand the benefits and drawbacks to using social networking platforms such as Instagram, to deliver health-based messages show low levels of participation.<sup>299</sup>

Instagram participation (liking and commenting on prompts) in the Instagram group was negatively correlated to reported Instagram use. This indicates that those participants who initially reported low Instagram usage were the most active on Instagram during the intervention. There was also no correlation detected between reported Instagram use and the major outcome measure of the intervention (SSB consumption, water consumption, total fluid consumption, total energy consumption, and HBI scores). Taken together this data shows that participant use and

familiarity with the platform did not influence the feasibility of the intervention. This indicates that a lack of previous experience with the Instagram platform does not present a significant barrier towards intervention feasibility.

The current popular belief is that screen time is associated with the rise in the obesity epidemic.<sup>300</sup> Contrary to this belief, evidence suggests frequent screen time use is not associated with weight or health status and is in fact associated with increased social health and stress coping behaviors.<sup>301,302</sup>

## **Limitations**

Several limitations can be noted. For the purposes of this study, researchers heavily relied on self-reported dietary intake data, which have potential bias and reporting errors.<sup>198</sup> However, the updated version of the BEVQ-15 has shown to be a valid and reliable beverage consumption tool.<sup>286</sup> Another limitation could be the potential for participants to display a learning effect as the same questionnaires were administered at multiple time points throughout the intervention period. Additionally, bias risk may serve as a limitation in cases in which participants may have misunderstood or misfiled a question. To aid in the mitigation of bias risk, researchers used validated and reliable measures in order to collect self-reported data. One difficulty that researchers faced was participants being able to retain their correct login information for the online BEVQ-15. In future studies, it is recommended that researchers set up each participant account in advance and provide each participant with their pre-assigned login information (i.e., username and password) in order to avoid potential disruption in data collection. Additionally, researchers would retain the ability to log onto individual participants online BEVQ-15 accounts to retrieve data and ensure completion of all study data collection timepoints.

The next limitation was the narrow diversity in racial/ethnic profiles and educational attainment of our sample population which was highly educated compared to the U.S. as a whole. Given high educational achievement of our recruited population, there may be limited generalizability of study findings beyond this academic culture. Future research would benefit from a more diverse participant pool. Nonetheless, reach and representativeness will help address important factors related to generalizability to other target populations as well as inform future studies on intervention design and potential areas for improvement.

The added complexity of conducting a human behavioral intervention during a global pandemic may have had some effect on the ability of researchers to recruit participants and to retain participation throughout the intervention and maintenance period. Due to a large majority of participants in the study identifying as working from home due to COVID-19, this may have impacted a number of factors, including participation, engagement, and retention.

## **Strengths**

Despite these limitations, this pilot study is the first to conduct a study looking at the effects of a worksite intervention aimed at improving beverage consumption patterns that was delivered completely through the social media networking website, Instagram. Additionally, the study was conducted as a randomized control pilot trial in which participants were randomly assigned to either the Instagram (social media) or E-mail (control) group. All data was collected through validated tools (i.e., questionnaires and surveys), pilot study data included both quantitative and qualitative data, and the entire study was employed at no cost to researchers.

Because the SIPsmartER curriculum has already proven effective in reducing SSB consumption, the use of SIPsmartER Lesson 1 curriculum materials adds additional strength to the overall study design and implementation. Finally, this pilot study design included a

maintenance period with follow-up from participants giving researchers further insight into program effectiveness.

## **Conclusions**

The Healthy Beverage Habits pilot study shows potential for reducing total beverage calories and improving HBI scores through an online delivery using Instagram. The findings from this study are similar to previous health behavior interventions delivered through Instagram, however, potentially due to small sample size and loss to follow-up, improvement was minimal. Findings from this study may be helpful to future researchers by suggesting a more technologically innovative approach to health behavior through the use of social media platforms in the development, implementation, and evaluation of behavioral interventions. Qualitative data from this study indicates that participants responded well to the Instagram delivery method. If proven effective, Instagram-delivered interventions may be a useful tool to promote worksite health promotion programs.

## Chapter 6: Conclusion and Future Directions

Obesity is known to be influenced by genetics, behavior, social environment, and economics; ultimately, having a large impact on an individual's overall health and well-being. The negative health outcomes associated with obesity include cardiovascular disease, type II diabetes, hypertension, stroke, dyslipidemia, osteoarthritis and reduced physical function, depression, and cancer.<sup>2,3</sup> Additionally, excessive sugar-sweetened beverage (SSB) consumption is associated with obesity,<sup>4,5</sup> diabetes,<sup>6-8</sup> and cardiovascular disease.<sup>5</sup>

Despite the recent surge in community health and public health promotion due to the COVID-19 pandemic, much remains to be understood in regards to the determinants and processes of population-level health behavior change.<sup>15</sup> Due to the importance of community prevention efforts to public health practice, it is critically important to find scientifically-based methods that promote health behavior change. If social influences are a primary factor in the adoption of health behaviors<sup>16,17</sup> and “an individual's behavior is shaped by the dynamic interaction with their social environment”,<sup>18,19</sup> research should study the effects a person's social environment can have on their health-related behaviors. Specifically, worksite health promotion programs are becoming increasingly more popular<sup>86</sup> and through promotion of healthy behaviors and encouraging positive health behavior change in the work environment.<sup>86</sup>

Unlike health-related conditions (e.g., blood pressure, diabetes, obesity, etc.), social media usage is relatively insulated from socioeconomic factors such as race, education, and location.<sup>28</sup> New estimates suggest seven-in-ten Americans use social media, illustrating how access to social media is becoming less of a barrier.<sup>29</sup> For many users, social media is part of their daily routine. Roughly 75% of Facebook users and 60% of Instagram users visit these social

networking websites at least once a day.<sup>29</sup> In 2018, the percentage of U.S. adults who engaged in Instagram had risen to 35%, up from just 9% in 2012.<sup>29</sup>

As illustrated in Chapter 5, this Healthy Beverage Habits pilot study shows potential for adapting the SIPsmartER: Lesson 1 curriculum into an online intervention aimed at improving beverage consumption patterns. There were no significant differences for any beverage variable between the Instagram and E-mail groups over time. However, for within group changes, Instagram significantly reduced total beverage kcals and significantly improved total HBI score, while the E-mail group did not demonstrate any significant changes. These results are similar to previous studies which have also shown Instagram, as a delivery method, is effective in online health behavior interventions.<sup>292-296</sup>

Findings from this study may be helpful to future researchers by suggesting a more technologically innovative approach to health behavior through the use of social media platforms in the development, implementation, and evaluation of behavioral interventions. Instagram, as an intervention delivery method, provides researchers with a convenient and accessible platform to communicate with participants through social media while simultaneously providing information to improve beverage consumption patterns and deserves further investigation.<sup>288</sup> If proven effective, Instagram-delivered interventions may be a useful tool to promote worksite health promotion programs. Findings from the systematic review assessing effectiveness of interventions using mobile phone delivery suggest that studies which employ multiple platforms in their intervention delivery tend to be more successful. Future interventions may have more success implanting their intervention across a variety of social media platforms.

Further research is needed to investigate the potential role social media has on human beverage consumption patterns. In addition to increasing the sample size, repeating this study

with the addition of random sampling across the U.S. population would provide greater validity to the updated BEVQ-15 as well as provide information on beverage patterns more generalizable to the U.S. population as a whole.

Extending the timeline of the study and repeating collection of measurements in future studies may help to tease out results related to social interaction versus the intervention itself. Other future directions might also include the addition of a range of social media platforms and the addition of personalized feedback for participants (e.g., direct messaging). Moreover, intervention materials should be more extensively modified to be delivered via Instagram. Further modifications to materials may include improving the overall tone of voice of messages as several participants expressed that messages were “preachy” or “like a sales pitch.” Adapting messages to a more accepting tone may help to improve overall reception of message content. Next steps should include a complete overhaul of the intervention itself as stated in the aforementioned modifications in Chapter 5, using the lessons learned from the Healthy Beverage Habits pilot study to inform modifications to the intervention delivery. Eventually the development and delivery of a full-scale beverage consumption social-media delivered educational intervention involving multiple types of social media platforms and including a more diverse population with varying levels of education would be ideal.

## References

1. Fryar CD CM, Afful J. Prevalence of overweight, obesity, and severe obesity among adults aged 20 and over: United States, 1960-1962 through 2017-2018. In: NCHS Health E-Stats; 2020.
2. Popkin BM, Kim S, Rusev ER, Du S, Zizza C. Measuring the full economic costs of diet, physical activity and obesity-related chronic diseases. *Obesity Reviews*. 2006;7(3):271-293.
3. Kopelman P. Health risks associated with overweight and obesity. *Obesity Reviews*. 2007;8:13-17.
4. Hu FB. Resolved: there is sufficient scientific evidence that decreasing sugar-sweetened beverage consumption will reduce the prevalence of obesity and obesity-related diseases. 2013;14(8):606-619.
5. Yang Q, Zhang Z, Gregg EW, Flanders WD, Merritt R, Hu FB. Added sugar intake and cardiovascular diseases mortality among US adults. *JAMA Internal Medicine*. 2014;174(4):516-524.
6. Imamura F, O'Connor L, Ye Z, et al. Consumption of sugar sweetened beverages, artificially sweetened beverages, and fruit juice and incidence of type 2 diabetes: systematic review, meta-analysis, and estimation of population attributable fraction. *Bmj*. 2015;351:h3576.
7. Malik VS, Popkin BM, Bray GA, Després J-P, Hu FB. Sugar-sweetened beverages, obesity, type 2 diabetes mellitus, and cardiovascular disease risk. *Circulation*. 2010;121(11):1356-1364.
8. O'Connor L, Imamura F, Lentjes MA, Khaw K-T, Wareham NJ, Forouhi NG. Prospective associations and population impact of sweet beverage intake and type 2 diabetes, and effects of substitutions with alternative beverages. *Diabetologia*. 2015;58(7):1474-1483.
9. 2015–2020 Dietary guidelines for Americans In: Promotion OoDPaH, ed. Washington (DC): USDA; 2015.
10. *Dietary Guidelines for Americans, 2020-2025*. U.S. Department of Agriculture and U.S. Department of Health and Human Services;2020.
11. Kit BK, Fakhouri TH, Park S, Nielsen SJ, Ogden CL. Trends in sugar-sweetened beverage consumption among youth and adults in the United States: 1999–2010. *American journal of clinical nutrition*. 2013;98(1):180-188.
12. Sharkey JR, Johnson CM, Dean WR. Less-healthy eating behaviors have a greater association with a high level of sugar-sweetened beverage consumption among rural adults than among urban adults. *Food Nutr Res*. 2011;55.
13. Kit BK, Fakhouri TH, Park S, Nielsen SJ, Ogden CL. Trends in sugar-sweetened beverage consumption among youth and adults in the United States: 1999-2010. *The American journal of clinical nutrition*. 2013;98(1):180-188.
14. Zoellner J, Krzeski E, Harden S, Cook E, Allen K, Estabrooks PA. Qualitative application of the theory of planned behavior to understand beverage consumption behaviors among adults. *J Acad Nutr Diet*. 2012;112(11):1774-1784.
15. Van den Broucke S. Why health promotion matters to the COVID-19 pandemic, and vice versa. In: Oxford University Press; 2020.

16. Smith KP, Christakis NA. Social networks and health. *Annu Rev Sociol.* 2008;34:405-429.
17. Pampel FC, Krueger PM, Denney JT. Socioeconomic disparities in health behaviors. *Annual review of sociology.* 2010;36:349-370.
18. McLeroy KR, Bibeau D, Steckler A, Glanz K. An ecological perspective on health promotion programs. *Health education quarterly.* 1988;15(4):351-377.
19. Stokols D. Translating social ecological theory into guidelines for community health promotion. *American journal of health promotion.* 1996;10(4):282-298.
20. Befort CA, Donnelly JE, Sullivan DK, Ellerbeck EF, Perri MG. Group versus individual phone-based obesity treatment for rural women. *Eating behaviors.* 2010;11(1):11-17.
21. Jovanović Ž, Crnčević-Orlić Ž, Štimac D, et al. Effects of obesity reduction on cardiovascular risk factors: comparison of individual and group treatment—substudy of the croatian healthy weight loss programme. *Collegium antropologicum.* 2009;33(3):751-757.
22. Paul-Ebhohimhen V, Avenell A. A systematic review of the effectiveness of group versus individual treatments for adult obesity. *Obesity facts.* 2009;2(1):17-24.
23. Renjilian DA, Perri MG, Nezu AM, McKelvey WF, Shermer RL, Anton SD. Individual versus group therapy for obesity: effects of matching participants to their treatment preferences. *Journal of consulting and clinical psychology.* 2001;69(4):717.
24. Butryn ML, Webb V, Wadden TA. Behavioral treatment of obesity. *Psychiatric Clinics.* 2011;34(4):841-859.
25. Hayaki J, Brownell K. Behaviour change in practice: group approaches. *International journal of obesity and related metabolic disorders: journal of the International Association for the Study of Obesity.* 1996;20:S27-30.
26. Latner JD, Stunkard AJ, Wilson GT, Jackson ML. The perceived effectiveness of continuing care and group support in the long-term self-help treatment of obesity. *Obesity.* 2006;14(3):464-471.
27. Perri MG, Nezu AM, McKelvey WF, Shermer RL, Renjilian DA, Viegner BJ. Relapse prevention training and problem-solving therapy in the long-term management of obesity. *Journal of consulting and clinical psychology.* 2001;69(4):722.
28. Chou W-YS, Hunt YM, Beckjord EB, Moser RP, Hesse BW. Social media use in the United States: implications for health communication. *Journal of medical Internet research.* 2009;11(4).
29. Social Media Fact Sheet. PEW Research Center; 2018. <http://www.pewinternet.org/fact-sheet/social-media/>.
30. Lemstra M, Bird Y, Nwankwo C, Rogers M, Moraros J. Weight loss intervention adherence and factors promoting adherence: a meta-analysis. *Patient preference and adherence.* 2016;10:1547.
31. Zhang J, Brackbill D, Yang S, Centola D. Efficacy and causal mechanism of an online social media intervention to increase physical activity: Results of a randomized controlled trial. *Prev Med Rep.* 2015;2:651-657.
32. Maloney-Krichmar D, Preece J. A multilevel analysis of sociability, usability, and community dynamics in an online health community. *ACM Transactions on Computer-Human Interaction.* 2005;12(2):201-232.
33. Brennan PF, Moore SM, Smyth KA. ComputerLink: electronic support for the home caregiver. *Advances in Nursing Science.* 1991.

34. Brennan PF, Ripich S. Use of a home-care computer network by persons with AIDS. *International journal of technology assessment in health care*. 1994;10(2):258-272.
35. King SA, Moreggi D. Internet therapy and self-help groups—the pros and cons. 1998.
36. Organization WH. Global Health Risk Mortality and burden of disease attributable to selected major risks. Geneva, Switzerland; 2009. In:2017.
37. Anderson LM, Quinn TA, Glanz K, et al. The effectiveness of worksite nutrition and physical activity interventions for controlling employee overweight and obesity: a systematic review. *American journal of preventive medicine*. 2009;37(4):340-357.
38. Lakerveld J, Mackenbach J. The upstream determinants of adult obesity. *Obesity facts*. 2017;10(3):216-222.
39. Krause K. Obesity and workers' compensation. *Arch Intern Med*. 2007;167:766-773.
40. Goetzel RZ, Ozminkowski RJ. What's holding you back: why should (or shouldn't) employers invest in health promotion. *Surgery and science combine to unlock the secrets of diabetes*. 2006;67(6):428.
41. Bly JL, Jones RC, Richardson JE. Impact of worksite health promotion on health care costs and utilization: evaluation of Johnson & Johnson's Live for Life program. *JAMA*. 1986;256(23):3235-3240.
42. Blackburn G. Effect of degree of weight loss on health benefits. *Obes Res*. 1995;3 Suppl 2:211s-216s.
43. Aneni EC, Roberson LL, Maziak W, et al. A systematic review of internet-based worksite wellness approaches for cardiovascular disease risk management: outcomes, challenges & opportunities. *PloS one*. 2014;9(1):e83594.
44. Goodman AB, Blanck HM, Sherry B, Park S, Nebeling L, Yaroch AL. Peer Reviewed: Behaviors and Attitudes Associated With Low Drinking Water Intake Among US Adults, Food Attitudes and Behaviors Survey, 2007. *Preventing chronic disease*. 2013;10.
45. Popkin BM, D'Anci KE, Rosenberg IHJNr. Water, hydration, and health. 2010;68(8):439-458.
46. Daniels MC, Popkin BM. Impact of water intake on energy intake and weight status: a systematic review. *Nutrition reviews*. 2010;68(9):505-521.
47. Sievenpiper JL, de Souza RJ. Are sugar-sweetened beverages the whole story? In: Oxford University Press; 2013.
48. Hedrick V, Davy B, Myers E, You W, Zoellner J. Changes in the healthy beverage index in response to an intervention targeting a reduction in sugar-sweetened beverage consumption as compared to an intervention targeting improvements in physical activity: Results from the talking health trial. *Nutrients*. 2015;7(12):10168-10178.
49. Duffey KJ, Davy BM. The healthy beverage index is associated with reduced cardiometabolic risk in US adults: A preliminary analysis. *Journal of the Academy of Nutrition Dietetics*. 2015;115(10):1682-1689. e1682.
50. Bleich SN, Vercammen KA, Koma JW, Li Z. Trends in Beverage Consumption Among Children and Adults, 2003-2014. *Obesity*. 2018;26(2):432-441.
51. Clark WF, Sontrop JM, Macnab JJ, et al. Urine volume and change in estimated GFR in a community-based cohort study. 2011;6(11):2634-2641.
52. Strippoli GF, Craig JC, Rohtchina E, Flood VM, Wang JJ, Mitchell P. Fluid and nutrient intake and risk of chronic kidney disease. *Nephrology*. 2011;16(3):326-334.
53. Roussel R, Fezeu L, Bouby N, et al. Low water intake and risk for new-onset hyperglycemia. *Diabetes care*. 2011;34(12):2551-2554.

54. Kolasa KM, Lackey CJ, Grandjean AC. Hydration and health promotion. *Nutrition Today*. 2009;44(5):190-201.
55. Popkin BM, D'Anci KE, Rosenberg IH. Water, hydration, and health. *Nutrition reviews*. 2010;68(8):439-458.
56. Electrolytes IoMPoDRIf, Water. *DRI, dietary reference intakes for water, potassium, sodium, chloride, and sulfate*. National Academy Press; 2004.
57. Armstrong LE, Johnson EC. Water intake, water balance, and the elusive daily water requirement. *Nutrients*. 2018;10(12):1928.
58. Turati F, Edefonti V, Bravi F, et al. Adherence to the European food safety authority's dietary recommendations and colorectal cancer risk. *European journal of clinical nutrition*. 2012;66(4):517-522.
59. Arcipowski E, Schwartz J, Davenport L, Hayes M, Nolan T. Clean Water, Clean Life: Promoting Healthier, Accessible Water in Rural Appalachia. *Journal of Contemporary Water Research & Education*. 2017;161(1):1-18.
60. Popkin BM, Barclay DV, Nielsen SJ. Water and food consumption patterns of US adults from 1999 to 2001. *Obesity research*. 2005;13(12):2146-2152.
61. Rolls BJ, Bell EA, Thorwart ML. Water incorporated into a food but not served with a food decreases energy intake in lean women. *The American journal of clinical nutrition*. 1999;70(4):448-455.
62. Armstrong LE. Hydration for Health Conference: paradigms and future directions. *Nutrition Today*. 2010;45(6):S45-S46.
63. Campbell SMJJotAcon. Hydration needs throughout the lifespan. 2007;26(sup5):585S-587S.
64. Popkin B, Bray G, Hu F. The role of high sugar foods and sugar-sweetened beverages in weight gain and obesity. *Managing Preventing Obesity: Behavioral Factors Dietary Interventions*. 2014:45-57.
65. Duffey KJ, Popkin BM. Shifts in patterns and consumption of beverages between 1965 and 2002. *Obesity*. 2007;15(11):2739-2747.
66. de Graaf C. Why liquid energy results in overconsumption. *Proceedings of the Nutrition Society*. 2011;70(2):162-170.
67. Han E, Powell LM. Consumption patterns of sugar-sweetened beverages in the United States. *Journal of the Academy of Nutrition and Dietetics*. 2013;113(1):43-53.
68. Willett W. Foreword. The validity of dietary assessment methods for use in epidemiologic studies. *Br J Nutr*. 2009;102 Suppl 1:S1-2.
69. Thompson FE, and Amy F. Subar. Dietary assessment methodology. In: Boushey ACC, ed. *Nutrition in the Prevention and Treatment of Disease*. 2 ed.2008.
70. Hooper LP, Myers EA, Zoellner JM, Davy BM, Hedrick VE. The Impact of Health Literacy Status on the Comparative Validity and Sensitivity of an Interactive Multimedia Beverage Intake Questionnaire. *Nutrients*. 2016;9(1).
71. Hedrick VE, Comber DL, Estabrooks PA, Savla J, Davy BM. The beverage intake questionnaire: determining initial validity and reliability. *Journal of the American Dietetic Association*. 2010;110(8):1227-1232.
72. Hedrick VE, Savla J, Comber DL, et al. Development of a brief questionnaire to assess habitual beverage intake (BEVQ-15): sugar-sweetened beverages and total beverage energy intake. *J Acad Nutr Diet*. 2012;112(6):840-849.

73. Hedrick VE, Comber DL, Ferguson KE, et al. A rapid beverage intake questionnaire can detect changes in beverage intake. *Eat Behav.* 2013;14(1):90-94.
74. Hedrick V, Myers E, Zoellner J, Duffey K, Davy B. Validation of a Rapid Method to Assess Habitual Beverage Intake Patterns. *Nutrients.* 2018;10(1):83.
75. Bleich SN, Vercammen KA, Koma JW, Li Z. Trends in Beverage Consumption Among Children and Adults, 2003-2014. *Obesity (Silver Spring).* 2018;26(2):432-441.
76. Singh GM, Micha R, Khatibzadeh S, et al. Global, Regional, and National Consumption of Sugar-Sweetened Beverages, Fruit Juices, and Milk: A Systematic Assessment of Beverage Intake in 187 Countries. *PLoS One.* 2015;10(8):e0124845.
77. Popkin BM, Hawkes C. Sweetening of the global diet, particularly beverages: patterns, trends, and policy responses. *Lancet Diabetes Endocrinol.* 2016;4(2):174-186.
78. Rehm CD, Peñalvo JL, Afshin A, Mozaffarian D. Dietary intake among us adults, 1999-2012. *JAMA.* 2016;315(23):2542-2553.
79. Pentz MA. Institutionalizing community-based prevention through policy change. *Journal of Community Psychology.* 2000;28(3):257-270.
80. Latkin CA, Knowlton AR. Social network assessments and interventions for health behavior change: a critical review. *Behavioral Medicine.* 2015;41(3):90-97.
81. Nackers LM, Dubyak PJ, Lu X, Anton SD, Dutton GR, Perri MG. Group dynamics are associated with weight loss in the behavioral treatment of obesity. *Obesity.* 2015;23(8):1563-1569.
82. Rizzo JA, Zyczynski TM, Chen J, Mallow PJ, Trudel GC, Penrod JR. Lost Labor Productivity Costs of Prostate Cancer to Patients and Their Spouses: Evidence From US National Survey Data. *J Occup Environ Med.* 2016;58(4):351-358.
83. Henke RM, Carls GS, Short ME, et al. The relationship between health risks and health and productivity costs among employees at Pepsi Bottling Group. *Journal of Occupational and Environmental Medicine.* 2010;52(5):519-527.
84. Durden ED, Huse D, Ben-Joseph R, Chu B-C. Economic costs of obesity to self-insured employers. *Journal of occupational and environmental medicine.* 2008;50(9):991-997.
85. Goetzel RZ, Ozminkowski RJ. The health and cost benefits of work site health-promotion programs. *Annu Rev Public Health.* 2008;29:303-323.
86. Baicker K, Cutler D, Song Z. Workplace wellness programs can generate savings. *Health affairs.* 2010;29(2):304-311.
87. Goetzel RZ. Examining the value of integrating occupational health and safety and health promotion programs in the workplace. *Rockville, Md: US Department of Health and Human Services, Public Health Services, Centers for Disease Control, National Institute of Occupational Health and Safety.* 2005.
88. Goetzel RZ, Hawkins K, Ozminkowski RJ, Wang S. The health and productivity cost burden of the “top 10” physical and mental health conditions affecting six large US employers in 1999. *Journal of occupational and environmental medicine.* 2003;45(1):5-14.
89. Goetzel RZ, Long SR, Ozminkowski RJ, Hawkins K, Wang S, Lynch W. Health, absence, disability, and presenteeism cost estimates of certain physical and mental health conditions affecting US employers. *Journal of Occupational and Environmental Medicine.* 2004;46(4):398-412.

90. Tsai SP, Ahmed FS, Wendt JK, Bhojani F, Donnelly RP. The impact of obesity on illness absence and productivity in an industrial population of petrochemical workers. *Annals of epidemiology*. 2008;18(1):8-14.
91. Kigozi J, Jowett S, Lewis M, Barton P, Coast J. The estimation and inclusion of presenteeism costs in applied economic evaluation: a systematic review. *Value in Health*. 2017;20(3):496-506.
92. Howarth A, Quesada J, Silva J, Judycki S, Mills PR. The impact of digital health interventions on health-related outcomes in the workplace: A systematic review. *Digital health*. 2018;4:2055207618770861.
93. Nicholson S, Pauly MV, Polsky D, et al. How to present the business case for healthcare quality to employers. *Applied Health Economics and Health Policy*. 2005;4(4):209-218.
94. Blumenthal D. Employer-sponsored health insurance in the United States-origins and implications. *New England Journal of Medicine*. 2006;355(1):82.
95. Fries JF, Harrington H, Edwards R, Kent LA, Richardson N. Randomized controlled trial of cost reductions from a health education program: the California Public Employees' Retirement System (PERS) study. *American Journal of Health Promotion*. 1994;8(3):216-223.
96. Leigh JP, Richardson N, Beck R, et al. Randomized controlled study of a retiree health promotion program: the Bank of America study. *Archives of Internal Medicine*. 1992;152(6):1201-1206.
97. Caloyeras JP, Liu H, Exum E, Broderick M, Mattke S. Managing manifest diseases, but not health risks, saved PepsiCo money over seven years. *Health Affairs*. 2014;33(1):124-131.
98. Claxton G, Rae M, Panchal N, et al. Health benefits in 2013: moderate premium increases in employer-sponsored plans. *Health Affairs*. 2013;32(9):1667-1676.
99. Merrill RM, Aldana SG, Garrett J, Ross C. Effectiveness of a workplace wellness program for maintaining health and promoting healthy behaviors. *Journal of occupational and environmental medicine*. 2011;53(7):782-787.
100. Poole K, Kumpfer K, Pett M. The impact of an incentive-based worksite health promotion program on modifiable health risk factors. *American Journal of Health Promotion*. 2001;16(1):21-26.
101. Hyatt Neville B, Merrill RM, Kumpfer KL. Longitudinal outcomes of a comprehensive, incentivized worksite wellness program. *Evaluation & the health professions*. 2011;34(1):103-123.
102. Milani RV, Lavie CJ. Impact of worksite wellness intervention on cardiac risk factors and one-year health care costs. *The American journal of cardiology*. 2009;104(10):1389-1392.
103. Davis L, Loyo K, Schwertfeger R, et al. Peer Reviewed: A Comprehensive Worksite Wellness Program in Austin, Texas: Partnership Between Steps to a Healthier Austin and Capital Metropolitan Transportation Authority. *Preventing chronic disease*. 2009;6(2).
104. Parks KM, Steelman LA. Organizational wellness programs: a meta-analysis. *Journal of occupational health psychology*. 2008;13(1):58.
105. O'Donnell MP. Integrating financial incentives for workplace health promotion programs into health plan premiums is the best idea since sliced bread. In:2010.

106. Chapman L. Employee participation in workplace health promotion and wellness programs: how important are incentives, and which work best? *North Carolina medical journal*. 2006;67(6):431.
107. Williams G, Hamm MP, Shulhan J, Vandermeer B, Hartling L. Social media interventions for diet and exercise behaviors: a systematic review and meta-analysis of randomized controlled trials. *BMJ open*. 2014;4(2):e003926.
108. Al-Eisa E, Al-Rushud A, Alghadir A, et al. Effect of Motivation by "Instagram" on Adherence to Physical Activity among Female College Students. *Biomed Res Int*. 2016;2016:1546013.
109. Richardson CR, Buis LR, Janney AW, et al. An online community improves adherence in an internet-mediated walking program. Part 1: results of a randomized controlled trial. *Journal of medical Internet research*. 2010;12(4):e71.
110. Hobbs WR, Burke M, Christakis NA, Fowler JH. Online social integration is associated with reduced mortality risk. *Proceedings of the National Academy of Sciences*. 2016;113(46):12980-12984.
111. Manago AM, Taylor T, Greenfield PM. Me and my 400 friends: the anatomy of college students' Facebook networks, their communication patterns, and well-being. *Dev Psychol*. 2012;48(2):369-380.
112. Zwier S, Araujo T, Boukes M, Willemsen L. Boundaries to the articulation of possible selves through social networking sites: the case of Facebook profilers' social connectedness. *Cyberpsychol Behav Soc Netw*. 2011;14(10):571-576.
113. Cavallo DN, Tate DF, Ries AV, Brown JD, DeVellis RF, Ammerman AS. A social media-based physical activity intervention: a randomized controlled trial. *American journal of preventive medicine*. 2012;43(5):527-532.
114. Millen DR, Patterson JF. Stimulating social engagement in a community network. Paper presented at: Proceedings of the 2002 ACM conference on Computer supported cooperative work2002.
115. Walther JB. Computer-mediated communication: Impersonal, interpersonal, and hyperpersonal interaction. *Communication research*. 1996;23(1):3-43.
116. Cummings JN, Butler B, Kraut R. The quality of online social relationships. 2002;45(7):103-108.
117. Spears R, Lea M. *Social influence and the influence of the 'social' in computer-mediated communication*. Harvester Wheatsheaf; 1992.
118. Preece J. Empathic communities: Reaching out across the web. *Interactions*. 1998;5(2):32-43.
119. Finn JJH, Work S. An exploration of helping processes in an online self-help group focusing on issues of disability. 1999;24(3):220-231.
120. Wellman B. Studying Personal Communities. In: Marsden PV, und Nan Lin (Hrsg.), ed. *Social Structure and Network Analysis*. Beverly Hills: London/New Delhi: Sage; 1982: S. 61-103.
121. Putnam RD. *Bowling alone: The collapse and revival of American community*. Simon and Schuster; 2001.
122. Liang X, Wang Q, Yang X, et al. Effect of mobile phone intervention for diabetes on glycemic control: a meta-analysis. *Diabetic medicine*. 2011;28(4):455-463.
123. Centola D. Social media and the science of health behavior. *Circulation*. 2013;127(21):2135-2144.

124. Haapala I, Barengo NC, Biggs S, Surakka L, Manninen P. Weight loss by mobile phone: a 1-year effectiveness study. 2009;12(12):2382-2391.
125. Chaudhry SI, Phillips CO, Stewart SS, et al. Telemonitoring for patients with chronic heart failure: a systematic review. 2007;13(1):56-62.
126. Eakin EG, Lawler SP, Vandelanotte C, Owen N. Telephone interventions for physical activity and dietary behavior change: a systematic review. 2007;32(5):419-434.
127. Jaana M, Paré G. Home telemonitoring of patients with diabetes: a systematic assessment of observed effects. 2007;13(2):242-253.
128. Revere D, Dunbar PJ. Review of computer-generated outpatient health behavior interventions: clinical encounters "in absentia". *Journal of the American Medical Informatics Association*. 2001;8(1):62-79.
129. Evers KE, Prochaska JM, Prochaska JO, Driskell M-M, Cummins CO, Velicer WF. Strengths and weaknesses of health behavior change programs on the Internet. 2003;8(1):63-70.
130. Marcus BH, Nigg CR, Riebe D, Forsyth L. Interactive communication strategies: implications for population-based physical-activity promotion. 2000;19(2):121-126.
131. Vandelanotte C, Spathonis KM, Eakin EG, Owen N. Website-delivered physical activity interventions: A review of the literature. 2007;33(1):54-64.
132. Patrick K. Information technology and the future of preventive medicine: potential, pitfalls, and policy. 2000;19(2):132-135.
133. Rice RE, Katz JE. Comparing internet and mobile phone usage: digital divides of usage, adoption, and dropouts. *Telecommunications Policy*. 2003;27(8-9):597-623.
134. Neuhauser L, Kreps GL. Rethinking Communication in the E-health Era. 2003;8(1):7-23.
135. Atkinson NL, Gold RS. The promise and challenge of eHealth interventions. 2002;26(6):494-503.
136. Clarke KK, Freeland-Graves J, Klohe-Lehman DM, Bohman TM. Predictors of weight loss in low-income mothers of young children. *Journal of the American Dietetic Association*. 2007;107(7):1146-1154.
137. Turner-McGrievy GM, Tate DF. Weight loss social support in 140 characters or less: use of an online social network in a remotely delivered weight loss intervention. *Transl Behav Med*. 2013;3(3):287-294.
138. Hales SB, Davidson C, Turner-McGrievy GM. Varying social media post types differentially impacts engagement in a behavioral weight loss intervention. *Transl Behav Med*. 2014;4(4):355-362.
139. Chang T, Chopra V, Zhang C, Woolford SJ. The role of social media in online weight management: systematic review. *Journal of medical Internet research*. 2013;15(11):e262.
140. Fjeldsoe BS, Marshall AL, Miller YD. Behavior change interventions delivered by mobile telephone short-message service. 2009;36(2):165-173.
141. Koivusilta LK, Lintonen TP, Rimpelä AH. Orientations in adolescent use of information and communication technology: a digital divide by sociodemographic background, educational career, and health. *Scandinavian Journal of Social Medicine*. 2007;35(1):95-103.
142. Lajunen H-R, Keski-Rahkonen A, Pulkkinen L, Rose RJ, Rissanen A, Kaprio J. Are computer and cell phone use associated with body mass index and overweight? A population study among twin adolescents. *J BMC Public Health*. 2007;7(1):24.

143. Leena K, Tomi L, Arja R. Intensity of mobile phone use and health compromising behaviors—how is information and communication technology connected to health-related lifestyle in adolescence? *Journal of adolescence*. 2005;28(1):35-47.
144. Struik LL, Baskerville NB. The role of Facebook in Crush the Crave, a mobile- and social media-based smoking cessation intervention: qualitative framework analysis of posts. *Journal of medical Internet research*. 2014;16(7):e170.
145. Moorhead SA, Hazlett DE, Harrison L, Carroll JK, Irwin A, Hoving C. A new dimension of health care: systematic review of the uses, benefits, and limitations of social media for health communication. *Journal of medical Internet research*. 2013;15(4).
146. Krukowski RA, Tilford JM, Harvey-Berino J, West DS. Comparing behavioral weight loss modalities: incremental cost-effectiveness of an internet-based versus an in-person condition. *Obesity*. 2011;19(8):1629-1635.
147. Meenan RT, Stevens VJ, Funk K, et al. Development and implementation cost analysis of telephone-and Internet-based interventions for the maintenance of weight loss. *International journal of technology assessment in health care*. 2009;25(3):400-410.
148. Sacks N, Cabral H, Kazis LE, et al. A web-based nutrition program reduces health care costs in employees with cardiac risk factors: before and after cost analysis. *Journal of medical Internet research*. 2009;11(4).
149. Laranjo L, Arguel A, Neves AL, et al. The influence of social networking sites on health behavior change: a systematic review and meta-analysis. *Journal of the American Medical Informatics Association*. 2015;22(1):243-256.
150. Hogan BE, Linden W, Najarian B. Social support interventions: Do they work? *Clinical psychology review*. 2002;22(3):381-440.
151. Kim C, McEwen LN, Kieffer EC, Herman WH, Piette JD. Self-efficacy, social support, and associations with physical activity and body mass index among women with histories of gestational diabetes mellitus. *Diabetes Educ*. 2008;34(4):719-728.
152. Greaves CJ, Sheppard KE, Abraham C, et al. Systematic review of reviews of intervention components associated with increased effectiveness in dietary and physical activity interventions. *BMC public health*. 2011;11:119.
153. Zhang J, Brackbill D, Yang S, Centola D. Efficacy and causal mechanism of an online social media intervention to increase physical activity: results of a randomized controlled trial. *Preventive medicine reports*. 2015;2:651-657.
154. Kumanyika SK, Wadden TA, Shults J, et al. Trial of family and friend support for weight loss in African American adults. *Arch Intern Med*. 2009;169(19):1795-1804.
155. Chancellor S, Hu A, De Choudhury M. Norms matter: contrasting social support around behavior change in online weight loss communities. Paper presented at: Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems 2018.
156. Turner-McGrievy G, Tate D. Tweets, Apps, and Pods: Results of the 6-month Mobile Pounds Off Digitally (Mobile POD) randomized weight-loss intervention among adults. *Journal of medical Internet research*. 2011;13(4):e120.
157. Semper HM, Povey R, Clark-Carter D. A systematic review of the effectiveness of smartphone applications that encourage dietary self-regulatory strategies for weight loss in overweight and obese adults. *Obes Rev*. 2016;17(9):895-906.
158. Sherrington A, Newham J, Bell R, Adamson A, McColl E, Araujo-Soares V. Systematic review and meta-analysis of internet-delivered interventions providing personalized

- feedback for weight loss in overweight and obese adults. *obesity reviews*. 2016;17(6):541-551.
159. Sherrington A, Newham JJ, Bell R, Adamson A, McColl E, Araujo-Soares V. Systematic review and meta-analysis of internet-delivered interventions providing personalized feedback for weight loss in overweight and obese adults. *Obes Rev*. 2016;17(6):541-551.
  160. Polzien KM, Jakicic JM, Tate DF, Otto AD. The efficacy of a technology-based system in a short-term behavioral weight loss intervention. *Obesity (Silver Spring)*. 2007;15(4):825-830.
  161. Social distancing, quarantine, and isolation. Centers for Disease Control and Prevention. <https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/social-distancing.html>. Published 2020. Accessed.
  162. Leigh-Hunt N, Bagguley D, Bash K, et al. An overview of systematic reviews on the public health consequences of social isolation and loneliness. *Public health*. 2017;152:157-171.
  163. Sippel LM, Pietrzak RH, Charney DS, Mayes LC, Southwick SM. How does social support enhance resilience in the trauma-exposed individual? *Ecology and Society*. 2015;20(4).
  164. Fry JP, Neff RA. Periodic prompts and reminders in health promotion and health behavior interventions: systematic review. *Journal of medical Internet research*. 2009;11(2):e16.
  165. Zoellner JM, Hedrick VE, You W, et al. Effects of a behavioral and health literacy intervention to reduce sugar-sweetened beverages: a randomized-controlled trial. *International Journal of Behavioral Nutrition and Physical Activity*. 2016;13(1):38.
  166. Ajzen I. From intentions to actions: A theory of planned behavior. In: *Action control*. Springer; 1985:11-39.
  167. Ajzen I. The Theory of Planned Behavior. *Organizational behavior and human decision processes*. 50(2):179-121.
  168. Delin JJoAL. Brand Tone of Voice: a linguistic analysis of brand positions. 2005;2(1).
  169. Hawkes C, Jewell J, Allen K. A food policy package for healthy diets and the prevention of obesity and diet-related non-communicable diseases: the NOURISHING framework. *Obesity reviews*. 2013;14:159-168.
  170. Organization WH. Global action plan for the prevention and control of noncommunicable diseases 2013-2020. World Health Organization. [https://apps.who.int/iris/bitstream/handle/10665/94384/9789241506236\\_eng.pdf?sequence=1](https://apps.who.int/iris/bitstream/handle/10665/94384/9789241506236_eng.pdf?sequence=1). Published 2013. Accessed 2019.
  171. Centers for Disease Control and Prevention CDC's Guide to Writing for Social Media. <http://www.cdc.gov/socialmedia/Tools/guidelines/pdf/GuidetoWritingforSocialMedia.pdf>. Published 2012. Accessed 2019.
  172. Mattson M, Basu AJHmq. The message development tool: a case for effective operationalization of messaging in social marketing practice. 2010;27(3):275-290.
  173. Buchholz SW, Wilbur J, Ingram D, Fogg L. Physical activity text messaging interventions in adults: a systematic review. *Worldviews on Evidence-Based Nursing*. 2013;10(3):163-173.
  174. Lewis S, Thomas SL, Hyde J, Castle D, Blood RW, Komesaroff PA. "I don't eat a hamburger and large chips every day!" A qualitative study of the impact of public health messages about obesity on obese adults. *BMC public health*. 2010;10(1):309.

175. Jensen M, Ryan D, Apovian C, et al. AHA/ACC/TOS guideline for the management of overweight and obesity in adults: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and The Obesity Society. *Circulation*. 2014;129(suppl 2):S139-S140.
176. Teixeira PJ, Carraca EV, Marques MM, et al. Successful behavior change in obesity interventions in adults: a systematic review of self-regulation mediators. *BMC medicine*. 2015;13(1):84.
177. Ackermann RT, Finch EA, Brizendine E, Zhou H, Marrero DG. Translating the Diabetes Prevention Program into the community: the DEPLOY pilot study. *American journal of preventive medicine*. 2008;35(4):357-363.
178. Lakerveld J, Bot SD, Chinapaw MJ, et al. Motivational interviewing and problem solving treatment to reduce type 2 diabetes and cardiovascular disease risk in real life: a randomized controlled trial. *International Journal of Behavioral Nutrition and Physical Activity*. 2013;10(1):47.
179. Eriksson MK, Franks PW, Eliasson M. A 3-year randomized trial of lifestyle intervention for cardiovascular risk reduction in the primary care setting: the Swedish Björknäs study. *PloS one*. 2009;4(4):e5195.
180. Kinmonth A-L, Wareham NJ, Hardeman W, et al. Efficacy of a theory-based behavioral intervention to increase physical activity in an at-risk group in primary care (ProActive UK): a randomized trial. *The Lancet*. 2008;371(9606):41-48.
181. van Sluijs EM, van Poppel MN, van Mechelen W. Stage-based lifestyle interventions in primary care: are they effective? *American journal of preventive medicine*. 2004;26(4):330-343.
182. Wing RR, Hill JO. Successful weight loss maintenance. *Annual review of nutrition*. 2001;21(1):323-341.
183. Rössner S, Hammarstrand M, Hemmingsson E, Neovius M, Johansson K. Long-term weight loss and weight-loss maintenance strategies. *Obesity reviews*. 2008;9(6):624-630.
184. Dombrowski SU, Avenell A, Sniehot FF. Behavioural interventions for obese adults with additional risk factors for morbidity: systematic review of effects on behaviour, weight and disease risk factors. *Obes Facts*. 2010;3(6):377-396.
185. Sherwood NE, Morton N, Jeffery RW, French SA, Neumark-Sztainer D, Falkner NH. Consumer preferences in format and type of community-based weight control programs. *Am J Health Promot*. 1998;13(1):12-18.
186. Arigo D, Pagoto S, Carter-Harris L, Lillie SE, Nebeker C. Using social media for health research: Methodological and ethical considerations for recruitment and intervention delivery. *Digital health*. 2018;4:2055207618771757.
187. Newman MG, Szkodny LE, Llera SJ, Przeworski A. A review of technology-assisted self-help and minimal contact therapies for drug and alcohol abuse and smoking addiction: is human contact necessary for therapeutic efficacy? *Clin Psychol Rev*. 2011;31(1):178-186.
188. Lerner D, Rodday AM, Cohen JT, Rogers WH. A systematic review of the evidence concerning the economic impact of employee-focused health promotion and wellness programs. *Journal of Occupational and Environmental Medicine*. 2013;55(2):209-222.
189. Colkesen EB, Niessen MA, Peek N, et al. Initiation of health-behavior change among employees participating in a web-based health risk assessment with tailored feedback. *Journal of occupational medicine and toxicology*. 2011;6(1):5.

190. Sethi S, Tyagi SK, Anurag RK. Plant-based milk alternatives an emerging segment of functional beverages: a review. *J Food Sci Technol*. 2016;53(9):3408-3423.
191. Han E, Powell LM. Consumption patterns of sugar-sweetened beverages in the United States. *J Acad Nutr Diet*. 2013;113(1):43-53.
192. Cade JE, Burley VJ, Warm DL, Thompson RL, Margetts BM. Food-frequency questionnaires: a review of their design, validation and utilization. *Nutr Res Rev*. 2004;17(1):5-22.
193. Raper N, Perloff B, Ingwersen L, Steinfeldt L, Anand J. An overview of USDA's Dietary Intake Data System. *J Food Compos Anal*. 2004;17(3):545-555.
194. Kearney J. Food consumption trends and drivers. *Philos Trans R Soc Lond B Biol Sci*. 2010;365(1554):2793-2807.
195. Bowes & Church's Food Values and Portions Commonly Used. . Lippincott-Raven; 1998.
196. Supertracker. U.S. Department of Agriculture. [www.WebAddress.gov](http://www.WebAddress.gov). Accessed 02/07/2017.
197. Cade J, Thompson R, Burley V, Warm D. Development, validation and utilization of food-frequency questionnaires—a review. *Public health nutrition*. 2002;5(4):567-587.
198. Willett W LE. *Nutritional Epidemiology*. 2nd ed ed. New York, NY: Oxford University Press; 1998.
199. Willett WC. Future directions in the development of food-frequency questionnaires. *The American journal of clinical nutrition*. 1994;59(1 Suppl):171S-174S.
200. Bland JM, Altman DG. Measuring agreement in method comparison studies. *Statistical methods in medical research*. 1999;8(2):135-160.
201. Giavarina D. Understanding Bland Altman analysis. *Biochem Med (Zagreb)*. 2015;25(2):141-151.
202. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics*. 1977;33(1):159-174.
203. Altman DG, Bland JM. Measurement in Medicine: The Analysis of Method Comparison Studies. *J Royal Stat Soc Series D (The Statistician)*. 1983;32(3):307-317.
204. Myles PS, Cui J. Using the Bland-Altman method to measure agreement with repeated measures. *British journal of anaesthesia*. 2007;99(3):309-311.
205. Kearney J. Food consumption trends and drivers. *Philos Trans Royal Soc B*. 2010;365(1554):2793-2807.
206. Ma Y, Olendzki BC, Li W, et al. Seasonal variation in food intake, physical activity, and body weight in a predominantly overweight population. *Eur J Clin Nutr*. 2006;60(4):519-528.
207. Moshfegh AJ, Rhodes DG, Baer DJ, et al. The US Department of Agriculture Automated Multiple-Pass Method reduces bias in the collection of energy intakes. *The American journal of clinical nutrition*. 2008;88(2):324-332.
208. Lasica JD, Institute A, Communications, Program S. *The Mobile Generation: Global Transformation at the Cellular Level : a Report of the Fifteenth Annual Aspen Institute Roundtable on Information Technology*. Aspen Institute Communications and Society Program; 2007.
209. Adler R. *Health care unplugged: the evolving role of wireless technology*. . Oakland, CA: California HealthCare Foundation; November 2007 2007.

210. Donner J. Research approaches to mobile use in the developing world: A review of the literature. *The information society*. 2008;24(3):140-159.
211. Donner J, Verclas K, Toyama K. Reflections on MobileActive 08 and the M 4 D Landscape. 2009.
212. McCarroll R, Eyles H, Mhurchu CN. Effectiveness of mobile health (mHealth) interventions for promoting healthy eating in adults: A systematic review. *Preventive Medicine*. 2017;105:156-168.
213. Cole-Lewis H, Kershaw T. Text messaging as a tool for behavior change in disease prevention and management. *Epidemiol Rev*. 2010;32:56-69.
214. Lim MSC, Hocking JS, Hellard ME, Aitken CK. SMS STI: A Review of the Uses of Mobile Phone Text Messaging in Sexual Health. *International Journal of STD & AIDS*. 2008;19(5):287-290.
215. Fjeldsoe BS, Marshall AL, Miller YD. Behavior Change Interventions Delivered by Mobile Telephone Short-Message Service. *American Journal of Preventive Medicine*. 2009;36(2):165-173.
216. Atun RA SS. *A review of the characteristics and benefits of SMS in delivering healthcare*. London: Vodafone;2006.
217. Swendeman D. Are mobile phones the key to HIV prevention for mobile populations in India? *The Indian journal of medical research*. 2013;137(6):1024-1026.
218. Kaplan WA. Can the ubiquitous power of mobile phones be used to improve health outcomes in developing countries? *Global Health*. 2006;2(1):9.
219. Nilsen W, Kumar S, Shar A, et al. Advancing the science of mHealth. *J Health Commun*. 2012;17 Suppl 1:5-10.
220. Rice RE, Katz JE. Comparing internet and mobile phone usage: digital divides of usage, adoption, and dropouts. *Telecommunications Policy*. 2003;27(8):597-623.
221. Center PR. Mobile Fact Sheet. Pew Research Center. <https://www.pewresearch.org/internet/fact-sheet/mobile/>. Published 2019. Accessed November 4, 2020, 2020.
222. Liang X, Wang Q, Yang X, et al. Effect of mobile phone intervention for diabetes on glycemic control: a meta-analysis: Mobile phone intervention and glycemic control. *Diabetic Medicine*. 2011;28(4):455-463.
223. Centola D. Social media and the science of health behavior. *Circulation*. 2013;127(21):2135-2144.
224. Haapala I, Barengo NC, Biggs S, Surakka L, Manninen P. Weight loss by mobile phone: a 1-year effectiveness study. *Public Health Nutr*. 2009;12(12):2382-2391.
225. Chaudhry SI, Phillips CO, Stewart SS, et al. Telemonitoring for patients with chronic heart failure: a systematic review. *Journal of cardiac failure*. 2007;13(1):56-62.
226. Eakin EG, Lawler SP, Vandelanotte C, Owen N. Telephone interventions for physical activity and dietary behavior change: a systematic review. *American Journal of Preventive Medicine*. 2007;32(5):419-434.
227. Jaana M, Paré G. Home telemonitoring of patients with diabetes: a systematic assessment of observed effects. *J Eval Clin Pract*. 2007;13(2):242-253.
228. Revere D, Dunbar PJ. Review of Computer-generated Outpatient Health Behavior Interventions: Clinical Encounters "in Absentia". *Journal of the American Medical Informatics Association*. 2001;8(1):62-79.

229. Evers KE, Prochaska JM, Prochaska JO, Driskell M-M, Cummins CO, Velicer WF. Strengths and Weaknesses of Health Behavior Change Programs on the Internet. *J Health Psychol.* 2003;8(1):63-70.
230. Marcus BH, Nigg CR, Riebe D, Forsyth LH. Interactive communication strategies Implications for population-based physical-activity promotion. *American Journal of Preventive Medicine.* 2000;19(2):121-126.
231. Vandelanotte C, Spathonis KM, Eakin EG, Owen N. Website-delivered physical activity interventions: A review of the literature. *American Journal of Preventive Medicine.* 2007;33(1):54-64.
232. Patrick K. Information technology and the future of preventive medicine Potential, pitfalls, and policy. *American Journal of Preventive Medicine.* 2000;19(2):132-135.
233. Neuhauser L, Kreps GL. Rethinking Communication in the E-health Era. *J Health Psychol.* 2003;8(1):7-23.
234. Atkinson NL, Gold RS. The Promise and Challenge of eHealth Interventions. *American Journal of Health Behavior.* 2002;26(6):494-503.
235. Clarke KK, Freeland-Graves J, Klohe-Lehman DM, Bohman TM. Predictors of Weight Loss in Low-Income Mothers of Young Children. *Journal of the American Dietetic Association.* 2007;107(7):1146-1154.
236. Turner-McGrievy GM, Tate DF. Weight loss social support in 140 characters or less: use of an online social network in a remotely delivered weight loss intervention. *Translational Behavioral Medicine.* 2013;3(3):287-294.
237. Chang T, Chopra V, Zhang C, Woolford SJ. The Role of Social Media in Online Weight Management: Systematic Review. *J Med Internet Res.* 2013;15(11):e262.
238. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Systematic Reviews.* 2021;10(1):89.
239. Hong QN, Fàbregues S, Bartlett G, et al. The Mixed Methods Appraisal Tool (MMAT) version 2018 for information professionals and researchers. *Education for Information.* 2018;34:285-291.
240. Hong QN, Pluye P, Fàbregues S, et al. Improving the content validity of the mixed methods appraisal tool: a modified e-Delphi study. *Journal of Clinical Epidemiology.* 2019;111:49-59.e41.
241. Hong QN, Fàbregues S, Bartlett G, et al. The Mixed Methods Appraisal Tool (MMAT) version 2018 for information professionals and researchers. *Education for Information.* 2018;34(4):285-291.
242. Allman-Farinelli M, Partridge SR, McGeechan K, et al. A Mobile Health Lifestyle Program for Prevention of Weight Gain in Young Adults (TXT2BFIT): Nine-Month Outcomes of a Randomized Controlled Trial. *JMIR mHealth and uHealth.* 2016;4(2):e78.
243. Buis LR, Hirzel L, Turske SA, Des Jardins TR, Yarandi H, Bondurant P. Use of a text message program to raise type 2 diabetes risk awareness and promote health behavior change (part II): assessment of participants' perceptions on efficacy. *Journal of medical Internet research.* 2013;15(12):e282.
244. Chen J-L, Guedes CM, Lung AE. Smartphone-based Healthy Weight Management Intervention for Chinese American Adolescents: Short-term Efficacy and Factors Associated With Decreased Weight. *Journal of Adolescent Health.* 2019;64(4):443-449.

245. Chung AE, Skinner AC, Hasty SE, Perrin EM. Tweeting to Health: A Novel mHealth Intervention Using Fitbits and Twitter to Foster Healthy Lifestyles. *Clinical pediatrics*. 2017;56(1):26-32.
246. Fjeldsoe BS, Goode AD, Phongsavan P, et al. Evaluating the Maintenance of Lifestyle Changes in a Randomized Controlled Trial of the 'Get Healthy, Stay Healthy' Program. *JMIR mHealth and uHealth*. 2016;4(2):e42.
247. Gilson ND, Pavey TG, Wright OR, et al. The impact of an m-Health financial incentives program on the physical activity and diet of Australian truck drivers. *BMC Public Health*. 2017;17(1):467.
248. Hebden L, Cook A, van der Ploeg HP, King L, Bauman A, Allman-Farinelli M. A mobile health intervention for weight management among young adults: a pilot randomized controlled trial. *Journal of human nutrition and dietetics : the official journal of the British Dietetic Association*. 2014;27(4):322-332.
249. Hurkmans E, Matthys C, Bogaerts A, Scheys L, Devloo K, Seghers J. Face-to-Face Versus Mobile Versus Blended Weight Loss Program: Randomized Clinical Trial. *JMIR mHealth and uHealth*. 2018;6(1):e14.
250. Jimoh F, Lund EK, Harvey LJ, et al. Comparing Diet and Exercise Monitoring Using Smartphone App and Paper Diary: A Two-Phase Intervention Study. *JMIR mHealth and uHealth*. 2018;6(1):e17.
251. Kerr DA, Harray AJ, Pollard CM, et al. The connecting health and technology study: a 6-month randomized controlled trial to improve nutrition behaviors using a mobile food record and text messaging support in young adults. *The international journal of behavioral nutrition and physical activity*. 2016;13:52.
252. Lubans DR, Smith JJ, Peralta LR, et al. A school-based intervention incorporating smartphone technology to improve health-related fitness among adolescents: rationale and study protocol for the NEAT and ATLAS 2.0 cluster randomized controlled trial and dissemination study. *BMJ open*. 2016;6(6):e010448.
253. Nezami BT, Ward DS, Lytle LA, Ennett ST, Tate DF. A mHealth randomized controlled trial to reduce sugar-sweetened beverage intake in preschool-aged children. *Pediatric obesity*. 2018;13(11):668-676.
254. Nystrom CD, Sandin S, Henriksson P, et al. Mobile-based intervention intended to stop obesity in preschool-aged children: the MINISTOP randomized controlled trial. *The American journal of clinical nutrition*. 2017;105(6):1327-1335.
255. Partridge SR, McGeechan K, Hebden L, et al. Effectiveness of a mHealth Lifestyle Program With Telephone Support (TXT2BFiT) to Prevent Unhealthy Weight Gain in Young Adults: Randomized Controlled Trial. *JMIR mHealth and uHealth*. 2015;3(2):e66.
256. Rodgers RF, Pernal W, Matsumoto A, Shiyko M, Intille S, Franko DL. Capitalizing on mobile technology to support healthy eating in ethnic minority college students. *Journal of American college health : J of ACH*. 2016;64(2):125-132.
257. Shapiro JR, Bauer S, Hamer RM, Kordy H, Ward D, Bulik CM. Use of Text Messaging for Monitoring Sugar-sweetened Beverages, Physical Activity, and Screen Time in Children: A Pilot Study. *J Nutr Educ Behav*. 2008;40(6):385-391.
258. Smith JJ, Morgan PJ, Plotnikoff RC, et al. Smart-phone obesity prevention trial for adolescent boys in low-income communities: the ATLAS RCT. *Pediatrics*. 2014;134(3):e723-731.

259. Partridge SR, McGeechan K, Bauman A, Phongsavan P, Allman-Farinelli M. Improved eating behaviors mediate weight gain prevention of young adults: moderation and mediation results of a randomized controlled trial of TXT2BFiT, mHealth program. *The international journal of behavioral nutrition and physical activity*. 2016;13:44.
260. You CW, Chen YC, Chen CH, et al. Smartphone-based support system (SoberDiary) coupled with a Bluetooth breathalyser for treatment-seeking alcohol-dependent patients. *Addictive behaviors*. 2017;65:174-178.
261. Hebden L, Cook A, van der Ploeg HP, King L, Bauman A, Allman-Farinelli M. A mobile health intervention for weight management among young adults: a pilot randomised controlled trial. *Journal of human nutrition and dietetics : the official journal of the British Dietetic Association*. 2014;27(4):322-332.
262. Fjeldsoe BS, Goode AD, Phongsavan P, et al. Evaluating the Maintenance of Lifestyle Changes in a Randomized Controlled Trial of the 'Get Healthy, Stay Healthy' Program. *JMIR mHealth and uHealth*. 2016;4(2):e42.
263. Lubans DR, Smith JJ, Plotnikoff RC, et al. Assessing the sustained impact of a school-based obesity prevention program for adolescent boys: the ATLAS cluster randomized controlled trial. *International Journal of Behavioral Nutrition and Physical Activity*. 2016;13(1):1-12.
264. Nyström CD, Sandin S, Henriksson P, et al. Mobile-based intervention intended to stop obesity in preschool-aged children: the MINISTOP randomized controlled trial. *The American journal of clinical nutrition*. 2017;105(6):1327-1335.
265. Rodgers RF, Pernal W, Matsumoto A, Shiyko M, Intille S, Franko DL. Capitalizing on mobile technology to support healthy eating in ethnic minority college students. *Journal of American College Health*. 2016;64(2):125-132.
266. Burke LE, Wang J, Sevick MA. Self-monitoring in weight loss: a systematic review of the literature. *Journal of the American Dietetic Association*. 2011;111(1):92-102.
267. Singh GM, Micha R, Khatibzadeh S, et al. Global, Regional, and National Consumption of Sugar-Sweetened Beverages, Fruit Juices, and Milk: A Systematic Assessment of Beverage Intake in 187 Countries. *PLoS One*. 2015;10(8):e0124845.
268. Mattson M, Basu A. The Message Development Tool: A Case for Effective Operationalization of Messaging in Social Marketing Practice. *Health Marketing Quarterly*. 2010;27(3):275-290.
269. Rimer BK, Glanz K, National Cancer I. Theory at a glance : a guide for health promotion practice. 2005.
270. Etikan I. Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics*. 2016;5(1).
271. Buis LR, Hirzel L, Turske SA, Des Jardins TR, Yarandi H, Bondurant P. Use of a Text Message Program to Raise Type 2 Diabetes Risk Awareness and Promote Health Behavior Change (Part II): Assessment of Participants' Perceptions on Efficacy. *J Med Internet Res*. 2013;15(12):e282.
272. Preece J. Online communities: designing usability, supporting sociability. *Industrial Management Data Systems*. 2000;100(9):459-460.
273. Hedrick VE, Davy BM, Duffey KJ. Is beverage consumption related to specific dietary pattern intakes? *Current Nutrition Reports*. 2015;4(1):72-81.
274. Bleich SN, Vercammen KA, Koma JW, Li Z. Trends in beverage consumption among children and adults, 2003-2014. *Obesity*. 2018;26(2):432-441.

275. Meit M, Knudson A, Gilbert T, et al. The 2014 update of the rural-urban chartbook. *Bethesda, MD: Rural Health Reform Policy Research Center*. 2014.
276. Sharkey JR, Johnson CM, Dean WR. Less-healthy eating behaviors have a greater association with a high level of sugar-sweetened beverage consumption among rural adults than among urban adults. *Food Nutr Res*. 2011;55(1):5819.
277. Casavale KO, Stoody EE, Rihane C, Olson R. Recommendations of the 2015-2020 Dietary Guidelines for Americans. *Faseb Journal*. 2016;30.
278. Davis AM, Bennett KJ, Befort C, Nollen N. Obesity and related health behaviors among urban and rural children in the United States: data from the National Health and Nutrition Examination Survey 2003–2004 and 2005–2006. *Journal of Pediatric Psychology*. 2011;36(6):669-676.
279. Lundeen EA, Park S, Pan L, O’Toole T, Matthews K, Blanck HM. Obesity prevalence among adults living in metropolitan and nonmetropolitan counties—United States, 2016. *Morbidity and Mortality Weekly Report*. 2018;67(23):653.
280. *Rural Health Disparities Rural Health Information Hub* updated November, 14th 2017.
281. Zoellner JM, Porter KJ, Chen Y, et al. Predicting sugar-sweetened behaviors with theory of planned behavior constructs: Outcome and process results from the SIP smart ER behavioral intervention. *Psychology & health*. 2017;32(5):509-529.
282. Berkman N, Sheridan S, Donahue K, et al. Health literacy interventions and outcomes: An updated systematic review (Evidence Report/Technology Assessment No. 199). *Rockville, MD: Agency for Healthcare Research and Quality*. 2011.
283. Glasgow RE, Vogt TM, Boles SM. Evaluating the public health impact of health promotion interventions: the RE-AIM framework. *American journal of public health*. 1999;89(9):1322-1327.
284. So J, Kim S, Cohen H. Message fatigue: Conceptual definition, operationalization, and correlates. *Communication Monographs*. 2017;84(1):5-29.
285. Nick EA, Cole DA, Cho S-J, Smith DK, Carter TG, Zelkowitz RL. The Online Social Support Scale: Measure development and validation. *Psychological assessment*. 2018;30(9):1127.
286. Fausnacht A, Myers E, Hess E, Davy B, Hedrick V. Update of the BEVQ-15, a beverage intake questionnaire for habitual beverage intake for adults: determining comparative validity and reproducibility. *Journal of Human Nutrition and Dietetics*. 2020;33(5):729-737.
287. Duffey KJ, Davy BM. The healthy beverage index is associated with reduced cardiometabolic risk in US adults: A preliminary analysis. *Journal of the Academy of Nutrition and Dietetics*. 2015;115(10):1682-1689. e1682.
288. Zoellner J, Chen Y, Davy B, et al. Talking health, a pragmatic randomized-controlled health literacy trial targeting sugar-sweetened beverage consumption among adults: rationale, design & methods. *Contemporary clinical trials*. 2014;37(1):43-57.
289. Chandra Y. SL. *Inductive Coding*. In: *Qualitative Research Using R: A Systematic Approach*. Singapore: Springer; 2019.
290. Virginia Tech Demographics. College Factual. <https://www.collegefactual.com/colleges/virginia-polytechnic-institute-and-state-university/student-life/diversity/>. Published 2021. Accessed April 1, 2021.

291. Zoellner JM, Hedrick VE, You W, et al. Effects of a behavioral and health literacy intervention to reduce sugar-sweetened beverages: a randomized-controlled trial. *International Journal of Behavioral Nutrition and Physical Activity*. 2016;13(1):1-12.
292. Al-Eisa E, Al-Rushud A, Alghadir A, et al. Effect of Motivation by “Instagram” on Adherence to Physical Activity among Female College Students. *BioMed Research International*. 2016;2016:1546013.
293. Santarossa S, Woodruff SJ. #LancerHealth: Using Twitter and Instagram as a tool in a campus wide health promotion initiative. *J Public Health Res*. 2018;7(1):1166-1166.
294. Chaudhary K, Dhillon M. “# FITNESS”: impact of Instagram on exercise adherence and self-efficacy. *International Journal of Sport and Exercise Psychology*. 2021:1-19.
295. Chung C-F, Agapie E, Schroeder J, Mishra S, Fogarty J, Munson SA. When Personal Tracking Becomes Social: Examining the Use of Instagram for Healthy Eating. Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems; 2017; Denver, Colorado, USA.
296. Koay S-H, Ng A-T, Tham S-K, Tan C-S. Gratitude Intervention on Instagram: An Experimental Study. *Psychological Studies*. 2020;65(2):168-173.
297. Vargas-Garcia E, Evans C, Prestwich A, Sykes-Muskett B, Hooson J, Cade J. Interventions to reduce consumption of sugar-sweetened beverages or increase water intake: evidence from a systematic review and meta-analysis. *Obesity Reviews*. 2017;18(11):1350-1363.
298. Blackstone S, Russie C. Using Instagram to deliver a theory-based wellness intervention designed to promote behavior change. *European Journal of Public Health*. 2020;30(Supplement\_5):ckaa166. 008.
299. Williams G, Hamm MP, Shulhan J, Vandermeer B, Hartling L. Social media interventions for diet and exercise behaviours: a systematic review and meta-analysis of randomised controlled trials. *BMJ open*. 2014;4(2).
300. Lee ST, Wong JE, Shanita SN, Ismail MN, Deurenberg P, Poh BK. Daily physical activity and screen time, but not other sedentary activities, are associated with measures of obesity during childhood. *International Journal of Environmental Research and Public Health*. 2015;12(1):146-161.
301. Relationships between Electronic Game Play, Obesity, and Psychosocial Functioning in Young Men. *CyberPsychology & Behavior*. 2009;12(2):241-244.
302. Jackson LA, von Eye A, Fitzgerald HE, Witt EA, Zhao Y. Internet use, videogame playing and cell phone use as predictors of children’s body mass index (BMI), body weight, academic performance, and social and overall self-esteem. *Computers in Human Behavior*. 2011;27(1):599-604.

# Appendices

## Appendix A.



**Office of Research Compliance**  
Institutional Review Board  
North End Center, Suite 4120, Virginia Tech  
300 Turner Street NW  
Blacksburg, Virginia 24061  
540/231-4806 Fax 540/231-0959  
email [irb@vt.edu](mailto:irb@vt.edu)  
website <http://www.irb.vt.edu>

### MEMORANDUM

**DATE:** June 20, 2016  
**TO:** Valisa Ellen Hedrick, Anna Lynn Gustafson  
**FROM:** Virginia Tech Institutional Review Board (FWA00000572, expires January 29, 2021)  
**PROTOCOL TITLE:** Updated BEVQ-15 Validation  
**IRB NUMBER:** 16-552

Effective June 17, 2016, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the New Application request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

<http://www.irb.vt.edu/pages/responsibilities.htm>

(Please review responsibilities before the commencement of your research.)

### PROTOCOL INFORMATION:

Approved As: **Expedited, under 45 CFR 46.110 category(ies) 3,4,7**  
Protocol Approval Date: **June 17, 2016**  
Protocol Expiration Date: **June 16, 2017**  
Continuing Review Due Date\*: **June 2, 2017**

\*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

### FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

*Invent the Future*

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY  
*An equal opportunity, affirmative action institution*

**Appendix B.**

Table 1. Summary of mobile technology-based beverage consumption interventions						
First Author (Year)	Population & Location	Study Design (length)	Objective/Purpose	Technology Used	Outcome Measures	Findings/Results
Allman-Farinelli (2016)	N=248 (young adults, 18-35 years) (152 female, 96 male) (BMI 25 to 31.9 kg/m <sup>2</sup> required) (Australia)	Two-arm parallel randomized controlled trial (12 weeks)	Assess maintenance outcomes of an mHealth intervention for prevention of weight gain in young adults	Phone calls, text messages, emails, mobile phone applications, & downloadable online resources	Primary: Self-reported weight change (kg) Secondary: physical activity and intake of fruits, vegetables, SSB, & take-out meals assessed via web-based surveys	Intervention participants weighed less at 12 weeks and after 9 months when compared with controls. No differences in physical activity were found. All diet behaviors showed the intervention group, compared with controls at 9 months, had greater odds of meeting recommendations for SSB.
Buis (2013)	N=161 (18-65 years) (73.7% female) (U.S.)	Efficacy evaluation and user survey (14 weeks)	Document txt4health efficacy by focusing on perceptions of satisfaction, usage, & behavior change among individuals who used txt4health in pilot studies	Text messages	Investigator-developed user survey included questions assessing txt4health use & perceptions, self-reported health and health behaviors, mobile phone use, demographics, & activation as measured by the Patient Activation Measure (PAM)	The majority of participants agreed/strongly agreed that after having completed txt4health, they were more likely to replace sugary drinks, such as juice or soda with water.
Chen (2017)	N=40 (adolescents, 13-18 years) (23 boys, 17 girls) (BMI > 85th percentile required) (U.S.)	Randomized control trial (6 months)	(1) measure effects of an innovative mobile phone technology-based intervention for overweight & obese adolescents (2) examine the intervention's feasibility for use in primary care clinics	Mobile phone-based with three components: Fitbit Flex (6 months), iStart Smart for Teens online educational program (3 months), & biweekly text messages during maintenance phase (3 months)	Anthropometrics (BMI & waist-to-hip ratio), blood pressure, levels of physical and sedentary activity, diet, & self-efficacy regarding physical activity & diet)	Mobile phone-based intervention participants had significant improvement in BMI, diastolic blood pressure, physical activity days per week, TV and computer time, servings of fruits and vegetables per day, servings of soda & sweetened drinks, physical activity self-efficacy, & dietary self-efficacy.
Chung (2017)	N=12 (students ≥ 18 years) OW group n= 7 females (BMI 25-34.9 kg/m <sup>2</sup> ) HW group n= 5 participants (1 female, 4 males) (BMI 22.5-24.9 kg/m <sup>2</sup> ) (U.S.)	Single arm intervention pilot study (2 months)	Development and pilot testing of an mHealth intervention to facilitate support for healthy lifestyle changes in overweight/obese (OW) & healthy weight (HW) young adults	Smartphone, Twitter, & Fitbit	Self-reported changes in fruit/vegetable & SSB intake over the intervention period compared to baseline self-reported values (baseline, 1 month, & 2 months)	92% of participants self-reported increased fruit intake (increased by 2.1 servings (OW) & 1.8 servings (HW)). 58% of participants self-reported increased vegetable intake (increased by 2.5 servings for OW and 0.5 servings for HW). 67% of participants decreased SSB intake. OW participants lost between 1-5 pounds & 3.9% -10.6% body fat versus 0.2-7 pounds & 0.5%-13.5% among HW participants.
First Author (Year)	Population & Location	Study Design (length)	Objective/Purpose	Technology Used	Outcome Measures	Findings/Results
Fjeldsoe (2016)	N=228 (18-65 years) (152 female, 76 male) (Australia)	Parallel randomized controlled trial (6 months)	Community-wide trial evaluating a text message (short message service, SMS)-delivered, extended contact intervention ('Get Healthy, Stay Healthy' (GHSH)), which followed on from a population-	Text messages	Primary outcomes: body weight, waist circumference, physical activity (walking, moderate, and vigorous sessions/week), & dietary behaviors (fruit & vegetable serves/day, cups of sweetened drinks per day, takeaway meals per week; fat, fiber & total indices from the Fat and Fiber	Intervention participants showed significant reductions in both body weight & waist circumference. No significant or meaningful intervention effect for dietary outcomes was observed.

First Author (Year)	Population & Location	Study Design (length)	Objective/Purpose	Technology Used	Outcome Measures	Findings/Results
			level, behavioral telephone coaching program		Behavior Questionnaire). Assessed via self-report at baseline & 6 months.	
Gilson (2017)	N=19 (men truckdrivers) (18-65 years) (Australia)	Feasibility multi-method, pre-post, and follow-up study (20 weeks)	Examine extent to which an m-Health financial incentives program facilitated physical activity and healthy dietary choices in Australian truck drivers	Activity tracker and smartphone application (Jawbone UP™)	Small positive changes in occupational physical activity, & fruit, vegetable, saturated fat & processed/refined sugar food/beverage choices	Non-significant increases in the mean proportions of work time spent physically active were found at end program & follow-up. Fruit & vegetable consumption significantly increased by one serve/day at end-program. Non-significant improvements in saturated fat & processed/refined sugar food/beverage choices were found at end-program & follow-up.
Hebden (2014)	N=51 (41 female, 10 male) (young adults, 18-35 years) (BMI 24-32 kg/m <sup>2</sup> required) (Australia)	Pilot randomized control trial (12 weeks)	Measure the effect of a mHealth intervention on body weight, body mass index and specific lifestyle behaviors addressed by the program	Short Message Service (SMS) text messages, e-mails, smartphone applications, & internet forums	Primary: body weight & BMI Secondary: online surveys (administered at baseline & 13 week follow-up) including sitting time, physical activity, weekly intake of SSB, energy-dense takeaway meals, & daily intake of fruit & vegetables	Decreased SSB intake. Post-intervention changes in outcomes were not significantly different from controls. Adjusting for baseline intake, there was no evidence of an effect of the mHealth intervention on SSB consumption. Controlling for baseline weight and gender, there was no evidence of an effect of the mobile intervention on body weight.
Hurkmans (2018)	N=81 (18-65 years) (BMI >29 kg/m <sup>2</sup> required) (Belgium)	Single-blinded randomized controlled trial (12 weeks)	Compare the effectiveness of different weight loss programs using a combination of conventional & mobile programs among adults who are overweight (BMI >29 kg/m <sup>2</sup> ).	Smartphone application	Primary outcomes: weight reduction (5% decrease of baseline weight in kg), BMI, metabolic risk factors, dietary pattern, & physical activity	Significantly more participants in all three intervention groups lost at least 5% or more of their weight at baseline compared with the control group. No significant difference was found between the combi group & the conventional group. A trend was found that more participants in the combi group lost 5% or more compared with the app group (19%). A significant time x group effect was found for BMI & metabolic risk factors, with the control group having the worst results & the combi group being significantly better with regard to BMI compared with the app group. No significant group x time effects were found for the intake of different food & drinks & moderate to vigorous physical activity (MVPA).
Jimoh (2018)	N34 (adolescents, 16-19 years) (11 male, 23 female) (U.K.)	Two-phase intervention study (8 weeks)	Investigate the use of a smartphone application (FoodWiz2) in supporting healthy lifestyle choices in adolescence	Smartphone application	Food intake & exercise	Record completion declined throughout the study, possibly affected by examination pressure. Food intake data showed increased fruit consumption & significantly reduced consumption of chocolate snacks & fizzy drinks among participants using the app. Questionnaire responses indicated that the app was generally preferred to the paper diary, in particular, the app was seen as less boring to use & more acceptable in social settings.

Kerr (2016)	N=247 (85 male, 162 female) (young adults, 18-30 years) (Australia)	Three-arm parallel, randomized control trial (6 months)	Evaluate the effectiveness of tailored dietary feedback & weekly text messaging to improve dietary intake of fruit, vegetables, & junk food	Mobile phone (camera & text messages)	Dietary intake was assessed using a mobile food record App (mFR) where participants captured images of foods & beverages consumed over 4-days at baseline & post-intervention. Primary outcomes: changes in servings of fruits, vegetables, energy-dense nutrient-poor (EDNP) foods & SSB. Intervention effects were assessed using linear mixed effect models for change in food group serves.	No changes in food group serves for either intervention groups were observed. An unanticipated outcome was a mean weight reduction of 1.7 kg among the dietary feedback only. Men who received dietary feedback only, significantly reduced their serves of EDNP foods. Women who received dietary feedback only significantly reduced their intake of SSB compared with controls.
Lubans (2016)	N=361 (adolescent boys aged 12-14 years)	Cluster randomized controlled trial (20-weeks)	Evaluate the effectiveness of a 20-week lifestyle intervention on teenage boys	Smartphone application	Primary outcomes: body mass index (BMI) & waist circumference Secondary outcomes: screen-time, physical activity, sedentary behavior, SSB consumption, muscular fitness, resistance training skill competency, & motivation for school sport.	No significant change in SSB consumption
Nezami (2018)	N=51 mother & child dyads (mothers w/ BMI of 25-50 kg/m <sup>2</sup> & preschool-aged children, 3-5 years, who consumed ≥ 12 fl. oz./day SSB/juice) (U.S.)	Randomized control trial (6-months)	Test the efficacy of a smartphone delivered intervention to reduce parent-provided SSB & juice consumption among children ages 3–5. An additional goal was to reduce maternal weight.	Smartphone-delivered (mobile website & text messages)	Dietary recalls to measure SSB & juice intake as well as to objectively measure maternal weight	Reduction in child SSB & juice for intervention group v. control at 6 months was statistically significant as well as maternal weight loss (intervention group lost 2.4kg at 6 months v. 0.9kg gain in control group).

First Author (Year)	Population & Location	Study Design (length)	Objective/Purpose	Technology Used	Outcome Measures	Findings/Results
Nystrom (2017)	N=281 (preschool-aged children, 4 years) (Sweden)	Two-arm parallel randomized control trial (6-months)	Examine the effectiveness of a mobile health (mHealth) obesity prevention program on body fat, dietary habits, and physical activity in healthy Swedish children	Smartphone application	Primary outcome: fat mass index (FMI)+F17 Secondary outcomes: intakes of fruits, vegetables, candy, and sweetened beverages and time spent sedentary and in moderate-to-vigorous physical activity.	No statistically significant intervention effect observed
Partridge (2015)	N=214 (young adults, 18-35 years) (BMI 25-31.9 kg/m <sup>2</sup> or recent weight gain required) (Australia)	Two-arm parallel randomized control trial (12-weeks)	Examine dietary patterns & diet quality of overweight young adults on enrollment into a mobile phone-based healthy lifestyle (mHealth) intervention (TXT2BFIT)	Email, telephone counseling, website, mobile phone application, & text messages	Assessed via online surveys at baseline & at 12 weeks, including self-reported weight, dietary, & physical activity measures	Intervention group was 2.2 kg lighter, increased total physical activity, consumed more vegetables, fewer sugary soft drinks, and fewer energy-dense takeout meals compared to controls.

Rodgers (2016)	N=43 (African American & Hispanic female full-time undergraduate students, ≥ 18 years) (U.S.)	Intervention study (3-weeks)	Evaluate the capacity of a mobile technology-based intervention to support healthy eating among ethnic minority female students	Smartphone (camera & text messages)	Participants were weighed at baseline & reported on fruit, vegetable, & SSB consumption	Among participants with body mass index (BMI) >25, fruit and vegetable consumption increased with time. Among participants with BMI <21, consumption of fruit decreased, whereas the consumption of vegetables remained stable. No effects were found for SSB consumption.
Shapiro (2008)	n=58 dyads (children aged 5-13 & parents)	Randomized control trial (8-weeks)	Examine acceptability, attrition, adherence, & preliminary efficacy of mobile phone short message service (SMS; text messaging) for monitoring healthful behaviors in children.	Mobile phone short message service (SMS; text messages)	Treatment acceptability, attrition, & adherence to self-monitoring.	No differences between groups in SSB consumption goals met.
Smith (2014)	N=361 (adolescent boys, 12-14 years) (Australia)	Cluster randomized controlled trial (20 weeks)	Evaluate the impact of the Active Teen Leaders Avoiding Screen-time (ATLAS) intervention for adolescent boys, an obesity prevention intervention using smartphone technology	Smartphone (application & website)	BMI, waist circumference, percent body fat, physical activity (accelerometers), screen-time, SSB intake, muscular fitness, & resistance training skill competency	No significant intervention effects for BMI, waist circumference, percent body fat, or physical activity. Significant intervention effects were found for screen-time, SSB consumption, muscular fitness, & resistance training skills.

## Appendix C.

**Table 2.** Individual Study Effectiveness at Reducing Sugar-Sweetened Beverage Intake (SSB).

Study	Sex Effectiveness		Age			Intervention Length					Technology Mode						Delivery Method		
	Male	Female	<18	18-35	36-65	3-4 Weeks	8 Weeks	12-14 Weeks	20 Weeks	6 Months	Phone Calls	Text Messaging	Mobile Phone Application	E-mail	Intervention Website	Social Media	Other	Digital	Combination
Allman-Feerinelli <sup>242</sup>	-	-	-	✓	-	-	-	✓	-	-	✓	✓	✓	✓	✓	-	✓	✓	-
Buis <sup>243</sup>	-	-	-	✓	✓	-	-	✓	-	-	-	✓	-	-	-	-	-	✓	-
Chen <sup>260</sup>	-	-	✓	-	-	-	-	-	-	✓	-	✓	-	-	✓	-	-	✓	-
Chung <sup>245</sup>	-	-	-	✓	-	-	✓	-	-	-	-	-	-	-	-	✓	-	✓	-
Fjeldsoe <sup>262</sup>	-	-	-	×	×	-	-	-	-	×	-	×	-	-	-	-	-	×	-
Gilson <sup>247</sup>	-	-	-	×	×	-	-	-	×	-	-	-	×	-	-	-	-	-	×
Hebden <sup>248</sup>	-	-	-	✓	-	-	-	✓	-	-	-	✓	✓	✓	✓	-	-	-	✓
Hurkmans <sup>249</sup>	-	-	-	✓	✓	-	-	✓	-	-	-	-	✓	-	-	✓	-	✓	-
Jimoh <sup>250</sup>	-	-	✓	✓	-	✓	-	-	-	-	-	-	✓	-	-	-	✓	✓	-
Kerr <sup>251</sup>	-	✓	-	✓	-	-	-	-	-	✓	✓	✓	✓	-	-	-	-	-	✓
Lubans <sup>263</sup>	-	-	×	-	-	-	-	-	×	-	-	-	×	-	-	-	-	-	×
Nezami <sup>253</sup>	-	-	✓	-	-	-	-	-	-	✓	-	✓	-	✓	✓	-	-	-	✓
Nystrom <sup>264</sup>	-	-	×	-	-	-	-	-	-	×	-	-	×	-	-	-	-	×	-
Partridge <sup>259</sup>	-	-	-	✓	-	-	-	✓	-	-	✓	✓	✓	✓	✓	-	✓	✓	-
Rodgers <sup>265</sup>	-	-	-	×	×	×	-	-	-	-	-	×	-	-	-	-	×	×	-
Shapiro <sup>257</sup>	-	-	×	-	-	-	×	-	-	-	-	×	-	-	-	-	-	×	-
Smith <sup>258</sup>	-	-	✓	-	-	-	-	-	✓	-	-	-	✓	-	✓	-	-	-	✓


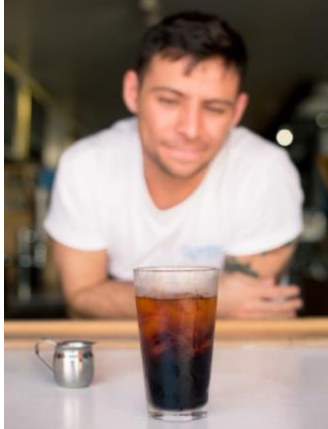
## Appendix D. Mixed Methods Appraisal Tool











Part I: Mixed Methods Appraisal Tool (MMAT), version 2018

Category of study designs	Methodological quality criteria	Responses			
		Yes	No	Can't tell	Comments
Screening questions (for all types)	S1. Are there clear research questions?				
	S2. Do the collected data allow to address the research questions? <i>Further appraisal may not be feasible or appropriate when the answer is 'No' or 'Can't tell' to one or both screening questions.</i>				
1. Qualitative	1.1. Is the qualitative approach appropriate to answer the research question?				
	1.2. Are the qualitative data collection methods adequate to address the research question?				
	1.3. Are the findings adequately derived from the data?				
	1.4. Is the interpretation of results sufficiently substantiated by data?				
	1.5. Is there coherence between qualitative data sources, collection, analysis and interpretation?				
2. Quantitative randomized controlled trials	2.1. Is randomization appropriately performed?				
	2.2. Are the groups comparable at baseline?				
	2.3. Are there complete outcome data?				
	2.4. Are outcome assessors blinded to the intervention provided?				
	2.5. Did the participants adhere to the assigned intervention?				
3. Quantitative non-randomized	3.1. Are the participants representative of the target population?				
	3.2. Are measurements appropriate regarding both the outcome and intervention (or exposure)?				
	3.3. Are there complete outcome data?				
	3.4. Are the confounders accounted for in the design and analysis?				
	3.5. During the study period, is the intervention administered (or exposure occurred) as intended?				
4. Quantitative descriptive	4.1. Is the sampling strategy relevant to address the research question?				
	4.2. Is the sample representative of the target population?				
	4.3. Are the measurements appropriate?				
	4.4. Is the risk of nonresponse bias low?				
	4.5. Is the statistical analysis appropriate to answer the research question?				
5. Mixed methods	5.1. Is there an adequate rationale for using a mixed methods design to address the research question?				
	5.2. Are the different components of the study effectively integrated to answer the research question?				
	5.3. Are the outputs of the integration of qualitative and quantitative components adequately interpreted?				
	5.4. Are divergences and inconsistencies between quantitative and qualitative results adequately addressed?				
	5.5. Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?				

**Appendix E.**

**Intervention Overview:** structure, theoretical constructs, objectives, and content.

Week # & Message #	Message Type	Objective	Image Content	Text Content
1.1	Message	Introduction and welcome		<p>Welcome to the Healthy Beverage Habits study! Throughout this study we will be providing you with informational messages and prompts to help you to improve your beverage consumption habits.</p> <p>Through dietary research, we know that our beverage consumption patterns influence our personal dietary patterns.</p> <p>What motivates you to improve your beverage consumption habits?</p> <p><b>Tip:</b> Ask someone to be your beverage buddy! Find a friend or family member who wants to improve their beverage consumption habits and do it together! This way you support each other.</p>
1.2	Message	Recognize that they drink too many SSBs		<p><b>Step One</b></p> <p>The first step to changing our habits is to better understand them.</p> <p>Now that you have completed the beverage questionnaire (BEVQ-15) and can see what beverages you consume throughout an average month, what are some of your favorite commonly consumed beverages?</p> <p><b>Tip:</b> Figure out what you like about your favorite sugar-sweetened drinks. Knowing if you like your favorite beverage because of its taste, its fizziness, or another reason can help you know what you might like about a non-sugar-sweetened alternative.</p>

<p>1.3</p>	<p>Prompt</p>	<p>Distinguish between SSBs and non-SSBs</p>	 <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="text-align: center;">  <p>Sugar-Sweetened Beverage</p> <ul style="list-style-type: none"> <li>Soda</li> <li>Black Coffee</li> <li>Sweet Tea</li> </ul> </div> <div style="text-align: center;">  <p>Non-Sugar-Sweetened Beverage</p> <ul style="list-style-type: none"> <li>Orange Juice</li> <li>Smoothie</li> <li>Green Tea</li> <li>Diet Soda</li> <li>Sparkling Water</li> <li>Energy Drink</li> <li>Tap Water</li> <li>Milk</li> <li>Sports Drink</li> </ul> </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="text-align: center;">  <p>Sugar-Sweetened Beverage</p> <ul style="list-style-type: none"> <li>Soda</li> <li>Sweet Tea</li> <li>Orange Juice</li> <li>Smoothie</li> <li>Energy Drink</li> <li>Sports Drink</li> </ul> </div> <div style="text-align: center;">  <p>Non-Sugar-Sweetened Beverage</p> <ul style="list-style-type: none"> <li>Black Coffee</li> <li>Green Tea</li> <li>Diet Soda</li> <li>Sparkling Water</li> <li>Tap Water</li> <li>Milk</li> </ul> </div> </div>	<p><b>Activity Time!</b></p> <p>A sugar-sweetened beverage (SSB) is any beverage that contains any added or natural sugar.</p> <p><b>Tip:</b> If the label has more than 0g of sugar, it is a sugar-sweetened beverage!</p> <p>Can you correctly categorize the following drinks as either SSB or non-SSB?</p> <p>How did you do?</p>
<p>2.1</p>	<p>Message</p>	<p>Distinguish between SSBs and non-SSBs</p>	 <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="text-align: center;">  <ul style="list-style-type: none"> <li>Soda/Pop</li> <li>Fruit Drinks</li> <li>Energy Drinks</li> <li>Coffee Drinks</li> <li>Milkshakes</li> </ul> </div> <div style="text-align: center;">  <ul style="list-style-type: none"> <li>100% Fruit Juice</li> <li>Sports Drinks</li> <li>Flavored Milk</li> </ul> </div> <div style="text-align: center;">  <ul style="list-style-type: none"> <li>Water</li> <li>Seltzer</li> <li>Unsweetened Tea</li> <li>Black Coffee</li> <li>Milk</li> <li>Diet Drinks</li> </ul> </div> </div>	<p><b>Traffic Lights</b></p> <p>One way to help guide us towards positive drinking habits is to remember the traffic lights!</p> <p>Red light beverages contain sugar and no other nutrients. Yellow light drinks contain sugar and a few other nutrients. Both red and yellow light drinks are sugar-sweetened beverages. Green light drinks either contain no sugar or some sugar with a lot of other nutrients.</p> <p>What color drinks do you consume the most? Which do you consume the least?</p>
<p>2.2</p>	<p>Prompt</p>	<p>Calculate current SSB intake</p>		<p><b>Activity Time!</b></p> <p>Using the chart, what do you drink in a typical day?</p> <p>Circle all the sugar-sweetened beverages.</p>

What do I drink each day?		
Time of Day	Beverage	Amount
With or before breakfast		
Mid-morning		
With lunch		
Afternoon		
With dinner		
Evening		
Any other time		

Draw a line through all the non-sugar-sweetened beverages.

Were you able to correctly distinguished between the sugar-sweetened and non-sugar-sweetened drinks in your chart?

2.3 Message

Identify SSB alternatives



Substituting zero calorie drinks in place of high calorie drinks is a great way to cut excess calories.

What are some of your favorite non-sugar-sweetened or zero calorie drinks?

**Tip:** Add flavorings to water or seltzer! Jazz up plain water or seltzer with slices of fruit or an ice cube made from frozen juice.

3.1 Prompt

Portion Sizes






**Activity Time!**

Portion sizes can be tricky. You have to think about sizes for cups and bottles and cans.

Can you guess each container to its fluid ounce volume?


When in doubt, check the container label for the ounces, measure it yourself, or try to always use the same size cup.

				
3.2	Prompt	Calculate current SSB intake		<p><b>Activity Time!</b>  A common rule of thumb is that 1oz of a sugar-sweetened beverage or SSB is equal to 1 packet, teaspoon, or cube of sugar.  *1 teaspoon sugar = 1 sugar cube = 1 sugar packet  Therefore, a 20oz Mountain Dew would contain about 20 packets of sugar!</p> <p>How many packets do you drink?  Add up how many ounces of sugary drinks you had yesterday.  Count one sugar packet for every ounce you drank.</p> <p><b>Tip:</b> If you want a sugar-sweetened beverage, order the smallest size; pick the smallest cup available; or choose mini cans instead of bottles.</p>
3.3	Message	Identify negative health impacts from drinking too many sugary drinks		<p>Those calories can really add up!</p> <p>Drinking one sugar-sweetened beverage or SSB each day can add up to 16 pounds gained in 1 year! Cutting out one SSB each day can add up to 16 pounds lost in 1 year!</p>

4.1

Prompt

Recognize that they drink too many SSBs



Beverages	Food
1 Krispy Cream Smoothie	12 chocolate eclairs
1 Gatorade	2 cans of Reddi-Whip
1 Arizona Iced Tea	4 bananas
1 bottle Sunkist Soda	6 Oreo ice cream sandwiches
1 Tropicana Twister Juice	6 bowls of fruit loops

Key

Beverages	Food
1 bottle Sunkist Soda	6 Oreo ice cream sandwiches
1 Krispy Cream Smoothie	12 chocolate eclairs
1 Arizona Iced Tea	6 bowls of fruit loops
1 Tropicana Twister Juice	2 cans of Reddi-Whip
1 Gatorade	4 bananas

**Activity Time!**

Let's compare sugar in sugar-sweetened beverages to that in foods.

Can you correctly match each beverage to the food that contains the same number of calories?

How did you do?

**Tip:** Have a sweet but healthy snack instead! If the sweet taste is really important to you, have a glass of water with a piece of fruit or sugar-free gum. You will satisfy your sweet tooth without all the sugar.

4.2

Message




Identify negative health impacts from drinking too many sugary drinks










Sugar-sweetened beverages and our health.



There have been well-established health risks of drinking too many sugar-sweetened beverages. These include weight gain (obesity/overweight), cavities/tooth decay, diabetes, hypertension, and cancer.

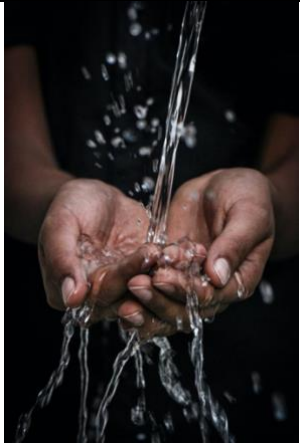

**Tip:** When you do the healthy thing by drinking fewer sugar-sweetened beverages, you are a role model, especially for your and your loved ones' children.

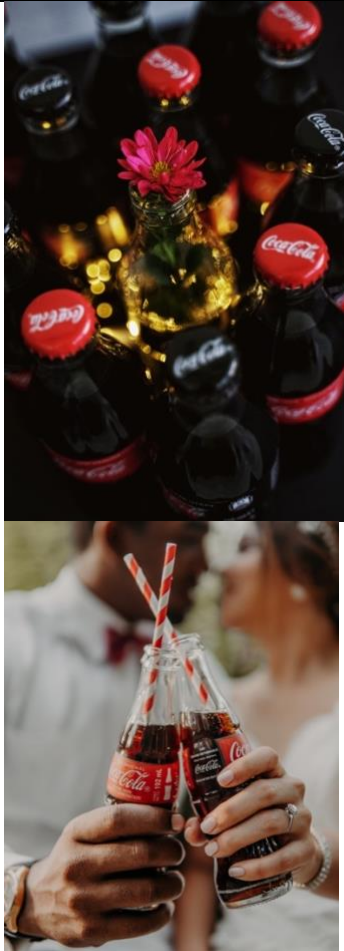

4.3	Message	Identify negative health impacts from drinking too many sugary drinks		<p>Let's discuss some of the ways in which sugar-sweetened beverages or SSBs can cause tooth decay.</p> <p>Sugar from food is “eaten” by bacteria in our mouths. This creates acids in our mouths and these acids “eat” tooth enamel causing cavities.</p> <p><b>Tip:</b> Be sure to brush your teeth after consuming SSBs or other sugary treats to avoid tooth decay!</p>
5.1	Message	Identify negative health impacts from drinking too many sugary drinks		<p>Sugar.</p> <p>Over consumption of sugar-sweetened beverages or SSBs can lead to type II diabetes.</p> <p>Our body needs insulin to bring sugar into cells to make energy. Too much sugar in our blood requires a lot of insulin to bring it into cells. Overtime, constantly having too much sugar in the blood can lead to insulin resistance and/or type II diabetes.</p> <p><b>Tip:</b> Make a half and half! This will help you get used to the taste over time. For example, try half-sweet and half-unsweet tea or half-coke and half-diet coke.</p>
5.2	Message	Identify negative health impacts from drinking too many sugary drinks		<p>Drink to your good health!</p> <p>Excess sugar-sweetened beverage intake is linked to greater risk of high blood pressure, heart attacks, strokes, and heart disease.</p>

5.3	Message	Identify negative health impacts from drinking too many sugary drinks		<p>Drinking sugar-sweetened beverages is a risky game.</p> <p>Being overweight is a risk for cancer. Having too many sugar-sweetened beverages can make us overweight. Therefore, consuming too many SSBs can increase our risk for cancer.</p> <p>Additionally, there is a strong link between being overweight or obese and an increased risk of 10 types of cancers:</p> <ul style="list-style-type: none"> <li>Liver</li> <li>Advanced prostate</li> <li>Ovarian</li> <li>Gallbladder</li> <li>Kidney</li> <li>Colorectal (bowel)</li> <li>Esophageal</li> <li>Postmenopausal breast</li> <li>Pancreatic</li> <li>Endometrial (womb)</li> </ul>
6.1	Prompt	Portion sizes	 	<p><b>Activity Time!</b></p> <p>Given the health risks, it is recommended that adults consume <math>\leq 8</math>oz of sugar-sweetened beverages each day.</p> <p>Can you correctly categorize which beverages are 8 oz and which are not?</p> <p><b>Tip:</b> Making an 8-ounce (or smaller) cup your everyday cup can help you drink less sugar-sweetened drinks.</p> <p>What do you think about the 8 oz recommendation? How does this make you feel?</p>

			<p style="text-align: center;">Key</p> 													
6.2	Prompt	Develop a personal action plan to reduce SSB intake, including goals and strategies.	 <p style="text-align: center;"><b>My Personal Action Plan</b></p> <p style="text-align: center;"><small>My Reasons Why I Want to Improve My Beverage Consumption Habits</small></p> <p>The most important reasons I _____ want to improve my beverage habits are</p> <p>_____</p> <p>_____</p> <p style="text-align: center;"><small>My Short and Long Term Drink Goals</small></p> <p>I currently drink about _____ ounces of sugar sweetened beverages each day.</p> <p>In 3-months, I pledge to drink _____ ounces of sugary drinks each day.</p> <p>My short-term goal is to drink _____ ounces a day this week ( _____ to _____).</p> <p style="text-align: center;"><small>My Short and Long Term Goals</small></p> <p>The obstacles that may make it harder for me to reach my goals and the strategies I can use to overcome them are</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">OBSTACLE</th> <th style="text-align: left;">STRATEGIES</th> </tr> </thead> <tbody> <tr> <td>1. _____</td> <td>1. _____</td> </tr> <tr> <td>2. _____</td> <td>2. _____</td> </tr> <tr> <td>3. _____</td> <td>3. _____</td> </tr> <tr> <td>4. _____</td> <td>4. _____</td> </tr> <tr> <td>5. _____</td> <td>5. _____</td> </tr> </tbody> </table>	OBSTACLE	STRATEGIES	1. _____	1. _____	2. _____	2. _____	3. _____	3. _____	4. _____	4. _____	5. _____	5. _____	<p><b>Activity Time!</b></p> <p>Think about which of these reasons are the most important motivations for you to improve your beverage consumption habits.</p> <p>Write down the most important personal motivation(s)</p> <p>Write the amount of SSBs you currently drink.</p> <p>Reflect about a change in your drink intake you would like to achieve over the next week (This is your short-term goal)</p> <p>Write these goals at the bottom of your <i>Personal Action Plan</i>.</p> <p>Be sure to set realistic goals that you believe you can achieve!</p> <p>*Remember! The recommendation is ≤8oz per day.</p> <p>Write a strategy for each barrier on your <i>Personal Action Plan</i>. Make these strategies personal, specific, and actionable so that the strategies will be more useful.</p>
OBSTACLE	STRATEGIES															
1. _____	1. _____															
2. _____	2. _____															
3. _____	3. _____															
4. _____	4. _____															
5. _____	5. _____															
6.3	Message	Identify barriers to meeting goals		<p>Making healthy beverage choices can sometimes be a struggle.</p> <p>Common barriers to having healthy beverage habits include taste, convenience, cost, peer pressure, caffeine, energy, habit, advertising, safety of water, artificial sweetener concerns, and just not knowing!</p> <p>What barriers do you face when choosing sugar-sweetened beverages</p>												

				<p>over water or non-sugar sweetened beverages?</p> <p><b>Tip:</b> When you have to use a larger cup for a sugar-sweetened beverage, add a lot of ice before you pour in your drink.</p>																																																																																	
7.1	Message	Identify barriers to meeting goals		<p>Who doesn't love saving money?</p> <p>Choosing water at the store, restaurant, or at home can be much cheaper than ordering a sugar-sweetened beverage. The savings really add up!</p> <p><b>Tip:</b> If you want to drink bottled water, gallon jugs are the least expensive option.</p> <p>Choosing SSBs over water can add up to close to \$2,000 per year on average. That's a chunk of change! What would you do with an extra \$2,000?</p>																																																																																	
7.2	Prompt	Accurately track daily SSB intake	 <p><b>My Weekly Drink Diary</b></p> <p><small>Directions: Each day, write down the sugar-sweetened beverages or SSBs you have at each time of the day. Only write down SSBs. Record the number of ounces that you drink. At the end of the day, add up how many ounces (oz) of SSBs you drink. At the end of the week, calculate your weekly average.</small></p> <table border="1"> <thead> <tr> <th></th> <th>Monday</th> <th>Tuesday</th> <th>Wednesday</th> <th>Thursday</th> <th>Friday</th> <th>Saturday</th> <th>Sunday</th> <th>Weekly Average</th> </tr> <tr> <th></th> <th>oz</th> <th>oz</th> <th>oz</th> <th>oz</th> <th>oz</th> <th>oz</th> <th>oz</th> <th>oz</th> </tr> </thead> <tbody> <tr> <td>Breakfast</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Mid-morning</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Lunch</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Afternoon</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Evening</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Weekend</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Daily Total</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Weekly Average		oz	oz	oz	oz	oz	oz	oz	oz	Breakfast									Mid-morning									Lunch									Afternoon									Evening									Weekend									Daily Total									<p><b>Activity Time!</b></p> <p>Tracking Beverage Intake: Please fill in the <i>Weekly Drink Diary</i> worksheet. Only record sugar-sweetened beverages (SSBs). Average total ounces per day of SSB for the whole week.</p> <p><b>Tip:</b> Tracking how many SSBs you consume is a great way to help know what you actually drink and if you are moving towards your goal.</p>
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Weekly Average																																																																													
	oz	oz	oz	oz	oz	oz	oz	oz																																																																													
Breakfast																																																																																					
Mid-morning																																																																																					
Lunch																																																																																					
Afternoon																																																																																					
Evening																																																																																					
Weekend																																																																																					
Daily Total																																																																																					

7.3	Message	Identify SSB alternatives		<p><b>Water Safety</b></p> <p>There may be times when you think your tap water may not be safe to drink. Because water is an inexpensive and usually easy to access non-sugar-sweetened beverage, being concerned about the safety of water can make drinking water hard and drinking more sugar-sweetened beverages easy.</p> <p><b>Tip:</b> Use a water filter at home or the office to take out byproducts that make water taste and smell bad. There are water filters that can fit on your faucet, pitcher, or reusable water bottle.</p>
8.1	Message	Identify SSB alternatives		<p><b>Artificial Sweeteners</b></p> <p>Many people have concerns about the safety of artificial sweeteners. However, many of these concerns are exaggerated or unsupported.</p> <p>In fact, there are much greater and more likely health risks from consuming too many sugar-sweetened beverages than there are from artificial sweeteners.</p> <p><b>Tip:</b> Don't like the taste of artificial sweeteners? Experiment! Not all artificial sweeteners taste the same. Try different ones in your iced tea or coffee until you find one that you like.</p>

8.2	Message	Identify barriers to meeting goals		<p><b>Bad Advertising</b></p> <p>Beverage companies create catchy advertisements to make you want to drink their sugar-sweetened beverages.</p> <p><b>Tip:</b> When reading, watching, or hearing an advertisement for SSBs, always ask yourself these questions:      Who is the advertisement for?      What looks and sounds too good to be true?      What isn't the ad saying?      How can I change this to make it more real?</p>
8.3	Message	Review		<p><b>Review!</b></p> <p>A sugary drink is any beverage that contains sugar and lacks other significant nutrients. The recommendation of sugary drinks is less than 8-ounces per day. There are health risks associated with drinking too many sugary drinks. Personal action plans and tracking what you drink are great tools to use as you try to improve your beverage habits.</p>

<sup>a</sup> adapted from SIPsmarter Lesson 1

## Appendix F. Social Media Usage Frequency Questionnaire

### Online Social Support Scale (OSSS)

Most sites, apps, services, and games on the Internet can be used in lots of different ways and for different purposes. We're interested in how much you use these online spaces to **connect or interact with other people**.

This means we **are** interested in how much you use these online spaces to talk with people, post, comment, like, send messages, game with others, etc.

This means we are **not** interested in how much you use these online spaces to scroll through other people's posts, watch or read content, or just look up information.

**How much** do you use the following sites, apps, services, or games to **connect or interact with other people**?

	0 = Never	1 = Rarely	2 = Sometimes	3 = Pretty Often	4 = A Lot
Facebook	0	1	2	3	4
Instagram	0	1	2	3	4
Twitter	0	1	2	3	4
Snapchat	0	1	2	3	4
Tumblr	0	1	2	3	4
Vine	0	1	2	3	4
YouTube	0	1	2	3	4
Pinterest	0	1	2	3	4
Reddit	0	1	2	3	4
Yik Yak	0	1	2	3	4
Kik	0	1	2	3	4
LinkedIn	0	1	2	3	4
GroupMe	0	1	2	3	4
WhatsApp	0	1	2	3	4
Google +	0	1	2	3	4
Whatsgoodly	0	1	2	3	4
Chat services	0	1	2	3	4
E-mail	0	1	2	3	4
Texting	0	1	2	3	4
Dating sites/apps (e.g., Tinder)	0	1	2	3	4
First person shooter games (e.g., Call of Duty)	0	1	2	3	4
Battle arena games (MOBAs: e.g., League of Legends)	0	1	2	3	4
Sports/fighting/racing games (e.g., FIFA, Street Fighter, Mario Kart)	0	1	2	3	4
Role-playing games (RPGs: e.g., World of Warcraft)	0	1	2	3	4
If you interact with people using other sites, apps, services, or games, please write them in and rate how often you use them:	0	1	2	3	4
_____	0	1	2	3	4
_____	0	1	2	3	4
_____	0	1	2	3	4

## Appendix G. Online Social Support Scale (OSSS)<sup>285</sup>

ONLINE SOCIAL SUPPORT

1143

Now, think about the online spaces you use above. Rate **how often** the following things have happened for you **while you interacted with others** online over the last two months. Use the following scale:

	0 = Never	1 = Rarely	2 = Sometimes	3 = Pretty Often	4 = A Lot
1. People show that they care about me online.	0	1	2	3	4
2. Online, people say or do things that make me feel good about myself.	0	1	2	3	4
3. People encourage me when I'm online.	0	1	2	3	4
4. People pay attention to me online.	0	1	2	3	4
5. I get likes, favorites, upvotes, views, etc. online.	0	1	2	3	4
6. I get positive comments online.	0	1	2	3	4
7. When I'm online, people tell me they like the things I say or do.	0	1	2	3	4
8. Online, people are interested in me as a person.	0	1	2	3	4
9. People support me online.	0	1	2	3	4
10. When I'm online, people make me feel good about myself.	0	1	2	3	4
11. When I'm online, I talk or do things with other people.	0	1	2	3	4
12. People spend time with me online.	0	1	2	3	4
13. People hang out and do fun things with me online.	0	1	2	3	4
14. Online, I belong to groups of people with similar interests.	0	1	2	3	4
15. People talk with me online about things we have in common.	0	1	2	3	4
16. Online, I connect with people who like the same things I do.	0	1	2	3	4
17. I am part of groups online.	0	1	2	3	4
18. When I'm online, people joke and kid around with me.	0	1	2	3	4
19. People relate to me through things I say or do online.	0	1	2	3	4
20. Online, people make me feel like I belong.	0	1	2	3	4
21. When I'm online, people give me useful advice.	0	1	2	3	4
22. Online, people provide me with helpful information.	0	1	2	3	4
23. If I had a problem, people would help me online by saying what they would do.	0	1	2	3	4
24. Online, people would tell me where to find help if I needed it.	0	1	2	3	4
25. People help me learn new things when I'm online.	0	1	2	3	4
26. People offer suggestions to me online.	0	1	2	3	4
27. People tell me things I want to know online.	0	1	2	3	4
28. When I'm online, people help me understand my situation better.	0	1	2	3	4
29. If I had a problem, people would share their point of view online.	0	1	2	3	4
30. People help me see things in new ways when I'm online.	0	1	2	3	4
31. People online would help me with money or other things if I needed it.	0	1	2	3	4
32. When I'm online, people help me with school or work.	0	1	2	3	4
33. Online, people help me get things done.	0	1	2	3	4
34. If I needed a hand doing something, I go online to find people who will help out.	0	1	2	3	4
35. Online, people offer to do things for me.	0	1	2	3	4
36. Online, people help me with causes or events that I think are important.	0	1	2	3	4
37. When I'm online, people have offered me things I need.	0	1	2	3	4
38. When I need something, I go online to find someone who might lend it to me.	0	1	2	3	4
39. When I need a hand with school or work things, I get help from others online.	0	1	2	3	4
40. I contact people online to get help or raise money for things I think are important.	0	1	2	3	4

## **Appendix H.**

### **Summative Evaluation**

*Well done, you have almost completed the 8-week Healthy Beverage Intervention! We would just like to ask you several more questions about your thoughts on the program. We are really interested in your honest opinions, including things you liked and things you didn't like about the program. Please don't think you are going to hurt our feelings, because all the information you provide will really help us evaluate the program and figure out how we can make it better for members in your community in the future.*

*We will ask you about your thoughts on the intervention and the resources provided.*

**[Instagram participants ONLY. If email, skip to question #8]**

**What was the biggest barrier for engaging in Instagram?**

**What could we have done differently increase your engagement in the program?**

**How much do you agree or disagree with the following statement: The Instagram application was easy to use.**

**Now that you have completed the program, were the Instagram posts  
Better than you thought they would be.**

**Just as good as you thought they would be.**

**Worse than you thought they would be.**

**What was the biggest barrier for you making posts?**

**What could our team have done differently increase your posting?**

**I would use the Instagram social media application again as a tool to provide me with strategies to promote healthy living.**

**[Instagram and Email groups]**

**The information provided me with useful strategies to help me reduce my sugary drinks.  
The information provided was personal.**

**How much do you agree or disagree with the statement: I was satisfied with the depth of information provided.**

**Please let us know about what you liked and disliked about intervention in the space below.**

**Overall, how satisfied were you with the information provided?**

**How satisfied were you with how the information provided was organized?**

**How satisfied were you with the type of information presented?**

**Can you please tell me about what you liked and disliked about the intervention?**

**Congratulations! You've made it to the end! Is there anything else that you'd like us to know?**

**Satisfaction Scale**

Extremetly Dissatisfied	Moderately Dissatisfied	Slightly Dissatisfied	Neutral	Slightly Satisfied	Moderately Satisfied	Extremely Satisfied
-------------------------	-------------------------	-----------------------	---------	--------------------	----------------------	---------------------

**Agreement Scale**

Strongly Disagree	Moderately Disagree	Slightly Disagree	Neutral	Slightly Agree	Moderately Agree	Strongly Agree
-------------------	---------------------	-------------------	---------	----------------	------------------	----------------

## Appendix I. IRB Approval Documentation



Division of Scholarly Integrity and  
Research Compliance  
Institutional Review Board  
North End Center, Suite 4120 (MC 0497)  
300 Turner Street NW  
Blacksburg, Virginia 24061  
540/231-3732  
irb@vt.edu  
<http://www.research.vt.edu/sirc/hrpp>

### MEMORANDUM

**DATE:** June 2, 2020  
**TO:** Valisa Ellen Hedrick, Anna Gustafson Fausnacht  
**FROM:** Virginia Tech Institutional Review Board (FWA00000572, expires October 29, 2024)  
**PROTOCOL TITLE:** Social Networking Worksite Wellness Intervention to Improve Beverage Consumption Patterns  
**IRB NUMBER:** 20-237

Effective June 1, 2020, the Virginia Tech Human Research Protection Program (HRPP) determined that this protocol meets the criteria for exemption from IRB review under 45 CFR 46.104(d) category (ies) 2(ii).

Ongoing IRB review and approval by this organization is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these activities impact the exempt determination, please submit an amendment to the HRPP for a determination.

This exempt determination does not apply to any collaborating institution(s). The Virginia Tech HRPP and IRB cannot provide an exemption that overrides the jurisdiction of a local IRB or other institutional mechanism for determining exemptions.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

<https://secure.research.vt.edu/external/irb/responsibilities.htm>

(Please review responsibilities before beginning your research.)

### PROTOCOL INFORMATION:

Determined As: **Exempt, under 45 CFR 46.104(d) category(ies) 2(ii)**  
Protocol Determination Date: **May 28, 2020**

### ASSOCIATED FUNDING:

The table on the following page indicates whether grant proposals are related to this protocol, and which of the listed proposals, if any, have been compared to this protocol, if required.

*Invent the Future*

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY  
*An equal opportunity, affirmative action institution*