Examining the Effects of Message Framing on Medication Beliefs, Intentions to Take Medication, Medication Adherence, and Asthma Control among College Students

by

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Abstract

Background: Asthma remains a burden to society with approximately $80 billion per year spent on asthma-related medical expenses in the United States. Inhaled corticosteroids (ICS), a mainstay medication for managing persistent asthma, have the potential to reduce the morbidity and frequent exacerbations associated with persistent asthma. However, young adults, in particular, are less likely to take their ICS as prescribed given their transition from adolescence to adulthood and decreased parental supervision. Message framing, a psychological approach which emphasizes losses or gains in message presentation and capitalizes on an individual's risk perceptions to influence his or her decision-making, may help.

Objectives: This study aims to: 1) develop gain- and loss-framed messages for medication adherence targeted at young adults with asthma; 2) examine the effects of gain- and loss-framed messages on Beliefs, Intentions to take medications, Medication Adherence, and Asthma Control; and 3) examine an hypothesized relationship between Message Frame, Beliefs, Intentions, Medication Adherence, and Asthma Control. The overall goal is to improve asthma control among young adults enrolled in college by utilizing message framing to address nonadherence.

Methods: First, a qualitative meta-synthesis of studies examining the experience of living with asthma among young adults was undertaken. Literature searches were conducted in PubMed, CINAHL, and PsycINFO, from inception through March 2019. A high sensitivity search of Google Scholar through March 2019 was also performed to identify additional articles. Qualitative and mixed study designs (studies using quantitative and qualitative methods) exploring the experiences of young adults with asthma were included. The rigor of included

studies was assessed using the Mixed Methods Appraisal Tool (MMAT). Grounded theory approach was used in synthesizing the data. Themes from the review were used in developing gain- and loss-framed messages for the promotion of medication adherence among young adults in college. Second, college students were recruited and randomized to receive either gain- or loss-framed messages three times per week for eight weeks. Data collection was performed at baseline, week four, and week eight. Measures included Beliefs, Intentions, Medication Adherence, and Asthma Control. Path analysis was used to assess the relationship between Message Frame, Beliefs, Intentions, Medication Adherence, and Asthma Control. Mixed-design ANOVA was used to assess whether Beliefs, Intentions, Medication Adherence or Asthma Control improved differentially from baseline across gain- and loss-frame groups.

Results: Seven high-quality studies with MMAT scores between 75-100% were identified for inclusion in the qualitative meta-synthesis. Five categories related to "living with asthma as a young adult" emerged: 1) needs (e.g., information on weather); 2) barriers (e.g., decreased parental support); 3) enablers (e.g., knowledge of asthma management); 4) behaviors (positive e.g., taking medication as prescribed; negative behaviors e.g., stopping medications when better); and 5) outcomes (disease, interpersonal, and personal outcomes). The emerging theory on the experience of living with asthma as a young adult posits that when needs are met, enablers are present, and barriers are removed, young adults are more likely to exhibit positive behaviors with desired outcomes. A total of 26 gain- and loss-framed messages were created from the themes, addressing the outcomes of living with asthma as a young adult.

Results from the framing intervention indicate that there was a significant difference in participants' Intentions to take medication as well as Asthma Control from baseline irrespective of the message frame. However, there was no difference between changes in Beliefs, Intentions,

Medication Adherence, and Asthma Control of participants receiving gain- versus loss-framed messages. Additionally, the intervention had no effects on Beliefs and Medication Adherence from baseline.

Findings from the path analysis reveal that Beliefs exert a large direct effect on Intentions (0.571), a medium direct effect on Medication Adherence (0.439), and a medium indirect effect on Medication Adherence, mediated by Intentions (0.222). These effects were all significant. Non-significant paths include the path from framing to Beliefs and Medication Adherence to Asthma control.

Conclusions: Young adults have several needs, barriers, enablers, behaviors, and outcomes as a result of living with asthma. In this study, framed mobile messages delivered via SMS improved young adults' intentions to take their medication as prescribed as well as their asthma control. Further studies with a control group are needed to support causality. A 100% retention rate and over 85% engagement rate suggests that young adults are comfortable receiving text messages promoting adherence to ICS. Beliefs about the necessity of ICS may lead to greater intentions to take the medications as well as consistent medication-taking behavior.

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List of Abbreviations

ACQ   Asthma Control Questionnaire

ACT   Asthma Control Test

BMQ   Beliefs about Medicines Questionnaire

CDC   Center for Disease Control and Prevention

ED   Emergency Departments

FEV   Forced Expiratory Volume

GINA   Global Initiative for Asthma

HPV   Human Papilloma Virus

ICS   Inhaled Corticosteroids

IRB   Institutional Review Board

MEMS   Medication Event Monitoring System

MID   Minimally Important Difference

US   United States

CHAPTER 1: INTRODUCTION

1.1 Background of the Problem

Asthma is a chronic respiratory disease of the airways that is characterized by recurrent wheezing, chest tightness, shortness of breath, and coughing.[1] Approximately 1.3 million outpatient visits and 10.5 million physician office visits were due to uncontrolled asthma in 2012.[2,3] In 2016, asthma contributed about 23.7 million disability adjusted life years globally.[4] According to the Center for Disease Control and Prevention (CDC), more than 11.5 million people reported having at least one or more asthma attacks in 2015.[5] Patients with asthma typically have lifestyle limitations and are restricted in their ability to participate in certain physical activities such as sports or going out with friends.[6,7] Furthermore, airway re-modelling in asthma can lead to functional damage of the airways and a possibility of developing chronic obstructive pulmonary disease.[8] Apart from the physical effects of asthma, studies have also shown that individuals with asthma are more prone to psychological symptoms such as anxiety, depression, lower cognitive function, poor concentration, and academic performance.[9,10] Furthermore, evidence suggests an association between asthma and suicide related behaviors including ideation, attempts, and completion.[11]

Inhaled corticosteroids (ICS), a mainstay treatment for persistent asthma may help to reduce the morbidity and mortality associated with uncontrolled asthma. Yet, people do not take their medications as prescribed. In one study, half the patients only refilled their ICS just once in 12 months.[12] Young adults are especially vulnerable to medication nonadherence, particularly intentional nonadherence.[13] Young adulthood (also referred to as emerging adulthood) represents the age where individuals are independent for the first time and may be new to chronic disease management.[13,14]

Additionally, the psychological effects associated with asthma, such as increased anxiety levels or depression pose additional risks to young adults.[10] Very limited studies have assessed the effects of interventions specifically intended to promote medication adherence among young adults. Although a pilot study intended to promote medication adherence specifically for this age group has been performed, it utilized a sub-group of this population (African-Americans).[15] Framing, a subtle variation on information presentation, has been used to influence health-behaviors.[16] Yet, the effects of message framing on medication adherence and asthma control among this population has not been examined.

1.1.1 Young (or Emerging) Adulthood

Young adults may be less adherent than other adults due to the unique challenges of emerging adulthood and being new to disease self-management.[14,17] Illness management including adherence to medications tends to decline during emerging adulthood with young adults more likely to receive ambulatory care from emergency departments compared to adolescents.[14,18] Young adulthood, is a developmental period that is marked with independence, decreased parental support and oversight, identity exploration, instability, self-focus, feeling in between adolescence and adulthood, development of new social networks, increased risk-taking behaviors, and low perception of risk.[13,17,19] It is also a period when individuals often assume responsibility for their own healthcare.[14] In terms of healthcare behavior, the effect of this developmental period may affect asthma management and medication adherence. Literature has suggested that young adults may be more susceptible to optimism bias, a tendency to believe they are less likely to experience a negative event as well as understanding the consequences of poor asthma management, leading them to make poor medication-taking decisions.[13,20] Past research has shown that young adults consciously refuse to take their medication as prescribed as

an assertion of their independence or control over asthma.[13] Young adults have also expressed

independence by adjusting medication doses based on perceived needs regardless of the

recommendations of their healthcare provider.[13] Additionally, young adults have also expressed

fear over the potential of becoming dependent on asthma medications.[13]

Apart from the effects of the developmental period of emerging adulthood, young adults

face several barriers. They often face economic barriers such as lack of insurance or inability to

afford medications.[13,21,22] This demographic has also reported a difficulty in getting time off of

school or work to make appointments with healthcare providers or refill their medications.[13]

Additionally, young adults have a need to fit with their peers rather than stand out.[23] As a result,

they may forgo taking their asthma medication in order to be accepted.[23] Furthermore, negative

perception of asthma medications and concerns about side effects and taste are also barriers to

medication adherence reported by young adults.[13,23,24]

1.1.2 Medication Nonadherence

Nonadherence to medications is complex and has been categorized as either intentional or

unintentional. In unintentional nonadherence, individuals have intentions to take medications as

instructed but fail to do so based on factors such as forgetfulness.[25,26] Interventions such as

reminders and dosage simplification have been used in cases of unintentional nonadherence.[27]

Intentional nonadherence follows an active decision not to take medications based on factors

such as beliefs, perceptions, and feelings.[25,26] Intentional nonadherence is critical in the

management of asthma because patients have been found to intentionally interrupt their ICS

based on waning symptoms or perceptions of need.[28] Furthermore, patients have reported their

dislike of medications and fatigue of long-term medication-taking as reasons for nonadherence to

inhaled corticosteroids.[24] While many interventions have been implemented to improve
adherence to ICS, very few address intentional nonadherence.[27,29]

In general, medication adherence may be measured using a direct or indirect method with
none being considered as a gold standard.[30] Direct approaches include detection or measurement
of a drug or its metabolite in the blood or urine, while indirect approaches includes methods such
as self-report, pill counts, and others.[30] One of the widely used self-report methods specific to
asthma is the Medication Adherence Report Scale for Asthma (MARS-A).[31] It consists of 10
items and answers to each item are rated on a five-point Likert-type scale from Always (1) to
Never (5). This measure has an adequate test-retest reliability ($r = 0.65$, $p < 0.001$) and a
moderate correlation with electronic adherence ($r = 0.42$, $p < 0.001$).[31] An example of a MARS-
A item is "I try to avoid using it."

1.1.3 Asthma Control

The goal of asthma management is asthma control. The Asthma Control Test (ACT) is
one of the reliable and valid self-report instruments for assessing asthma control.[32] This
questionnaire consists of five items, with each item scored from 1 to 5. The ACT yields a
summary score that ranges from 5 to 25. Scores of 19 and less are considered to indicate poor
asthma control. The ACT has demonstrated reliability in a study by Schatz and colleagues, with
a high internal consistency of 0.85 and a test-retest reliability of 0.77.[33] An example of an ACT
item is, "During the past four weeks, how often have you had shortness of breath?"

1.2 Theoretical Background

Prospect Theory: According to Prospect Theory, when confronted with two choices – one that
poses little risk and another that poses a higher level of risk— an individual's preference will

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depend on how the choices are framed.[34,35] Individuals change preferences when the decision

problem is framed in different ways such as gain versus loss.[34] This is a departure from the

Expected Utility Theory which assumes that most individuals are rational decision makers.[34]

Framing has been used in various decision-making situations to influence peoples' judgement

and decision-making and can have a direct effect on preference reversals.[36-38] Three general

types of framing have been identified: risky choice, attribute, and goal framing.[39] Risky choice

framing, introduced by Tversky and Kahneman (1981), involves the manipulation of two choice

options such that one option represents a gain (or loss) and the other represents a risky alternative

with numeric probabilities. Typically, people respond to risky choice framing by being more

risk-taking when information is presented as avoiding loss than when comparable gains are

emphasized.[39] In attribute framing, the attributes or characteristics of an object or event serves as

the focus of the framing manipulations. For example, cesarean section (a surgical event) has an

attribute of survival as an outcome. This attribute could be described as, "the chance of survival

with cesarean section is 98 percent" versus "the chance of mortality with cesarean section is

2%". Goal framing, the third type of framing, frames the relationship between behaviors and

goal attainment. Typically, a goal framed message stresses the positive consequences of

performing an act (gain-frame) or the negative consequences of not performing the act (loss-

frame).[39] Past research, including those conducted in health settings, have mostly found that loss-

frames yield more impact compared to gain-frames.[40-44] These findings are consistent with

Tversky and Kahnemans' loss aversion concept which implies that people are more risk averse to

loss than they are to gains of equal magnitude.[45] Rothman and Salovey explained that the

persuasiveness of gain- versus loss-framed messages depended on whether the behavior was

focused on the discovery (detection behavior) or prevention (preventive behavior) of a health

problem.[46] They suggested that loss-framed messages should be more persuasive in promoting detection behavior while gain-framed messages should be more persuasive in promoting preventive behavior. Accordingly, a recent meta-analysis found that gain-framed messages are more effective than loss-framed messages in promoting health behaviors that are intended to prevent an illness (e.g., exercise).[16]

Outcome Expectancy: Outcome expectancy is a construct found in three theories of behavior change: The Theory of Reasoned Action, the Theory of Planned Behavior, and the Social Cognitive Theory. In the Theory of Reasoned Action and Theory of Planned Behavior, outcome expectancy is conceptualized as behavioral beliefs. Behavioral beliefs are an individual's positive or negative valuation of a behavior and are believed to influence an individual's attitude towards a behavior.[47] Behavioral beliefs related to medication taking among asthma patients include perceptions of medication, perceptions that medications are not effective, perceptions of medication taking as inconvenient, perceptions of asthma as episodic rather than chronic, necessity to take medications during symptom free periods, fear of side effects, and concerns about social stigma associated with taking asthma medications.[48-51]

In the Social Cognitive Theory (Figure 1.1), outcome expectancy is the expected consequences of one's behavior. People adopt behaviors or actions that are likely to produce positive outcomes while discarding those that bring negative outcomes.[52] According to this theory, outcome expectancy is derived largely from previous experience and is subjective to the individual.[52,53]

Intentions: The intentions construct is central to the Theories of Reasoned Action and Planned Behavior. It indicates the effort or extent of willingness of an individual to perform a behavior.[47] Intentions are believed to be the best predictor of behavior with greater levels of intention

associated with a greater likelihood to perform a behavior.[54,55] Indeed, several studies have found

intentions to be a strong predictor of behavior. According to the Theory of Planned Behavior

(Figure 1.2), intentions are informed by attitude (behavioral beliefs and outcome evaluation),

subjective norm (normative beliefs and motivation to comply), and perceived behavioral control

(control beliefs and perceived power).[47] The Theory of Reasoned Action is similar to the Theory

of Planned Behavior but without a perceived behavioral-control component.[56,57] Intentions are

also a core construct in several other theories including the Technology Acceptance Model and

the Unified Theory of Acceptance and Use of Technology.[58,59] Several studies have found

behavioral beliefs to be a strong predictor of intentions, hence the interest in examining

behavioral beliefs as it pertains to intentions. Studies have also found more positive beliefs about

medications among adherent patients compared to non-adherent patients.[60] However, the role of

framing on beliefs, specifically, outcome expectancy, and intentions to take medications has not

been studied.

Figure 1.1 Social Cognitive Theory
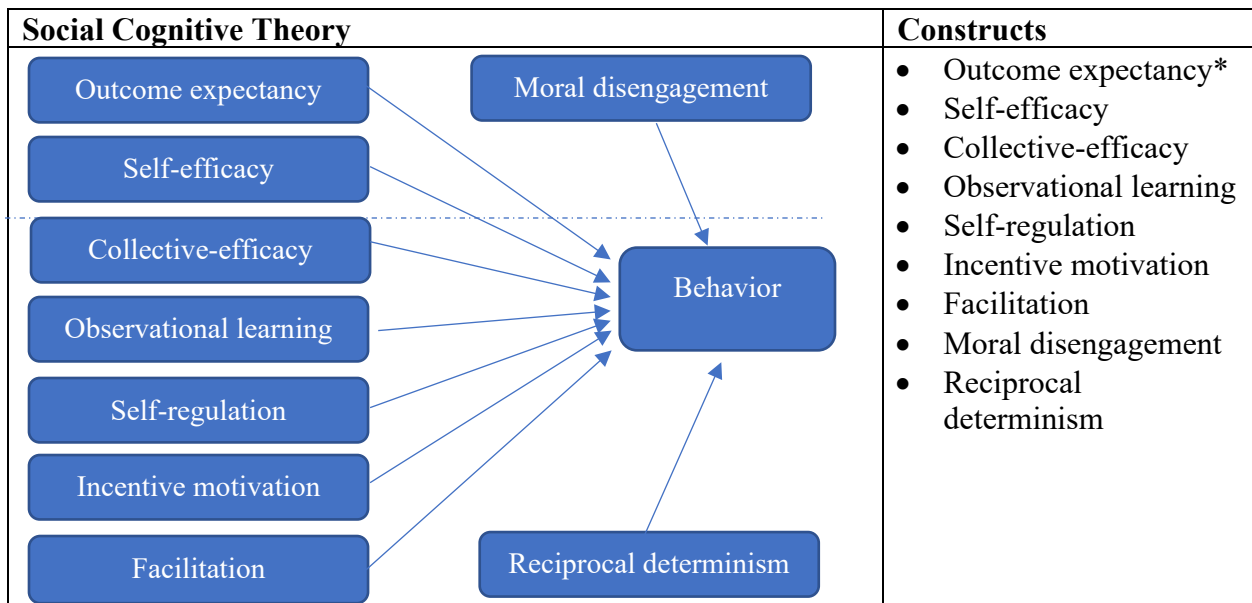
Figure 1.2 Theory of Planned Behavior

Theory of Planned Behavior	Constructs
	- Attitude - Behavioral beliefs* - Evaluation of behavioral outcomes - Subjective norms - Normative beliefs - Motivation to comply - Intentions* - Perceived behavioral control - Control beliefs - Perceived power
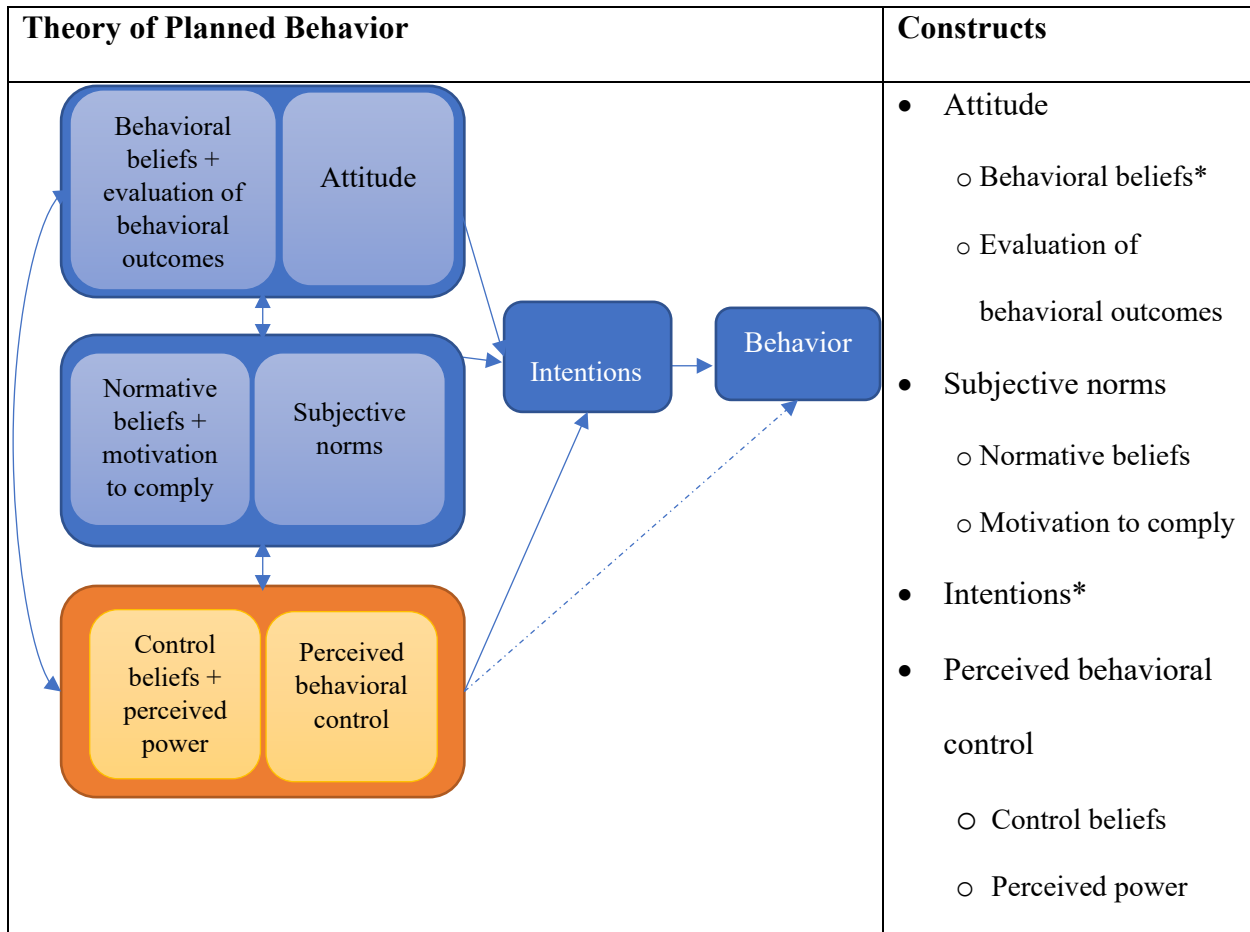
*Construct is used in the study
Blue area shows the Theory of Reasoned Action; The entire diagram shows the Theory of Planned Behavior.

1.2.1 Text Messaging

According to the World Health Organization's definition of mHealth –the use of mobile and wireless technology to support healthcare objectives— the use of text messages to deliver health interventions may be considered mHealth.[61] mHealth have been used to support a wide range of health behavior change interventions with positive results. Two recent systematic reviews report the effectiveness of mHealth, including text messaging interventions in improving

health outcomes.[62,63] These studies have also commented on the acceptability of text messages for health interventions.

Text messages have been successfully utilized in medication adherence interventions targeted at young adults with significant improvements in adherence.[15,64] A study promoting medication adherence among young African-American adults found significant improvements in adherence to ICS.[15] Also, young adults have indicated their acceptance and satisfaction with interventions that utilize text messages to promote health behaviors.[23,64] To this end, we expect that using text messages to deliver framed messages would be acceptable to young adults.

1.3 Problem Statement

Intentional nonadherence is critical in the management of asthma because patients have been found to intentionally interrupt their ICS based on waning symptoms or perceptions of need.[65] Furthermore, patients have reported their dislike of medications, and fatigue of long-term medication-taking as reasons for nonadherence to ICS.[65,66] While many interventions have been performed to improve adherence to ICS, very few address intentional nonadherence.[27] Young adults have been known to intentionally stop their medications due to illness perceptions, medication concerns, and their assertion of independence.[13,24] Young adulthood is an age of instability, identity exploration, self-focus, possibilities including optimistic bias, and feeling in between.[20] As a result, they have distinct challenges in chronic disease management because of the unique characteristics of this developmental phase as well as being newly independent and decreased parental supervision.[13] An intervention specifically targeted to young adults that utilizes proven concepts of decision-making to address intentional nonadherence may be effective in addressing asthma control in this population.

1.3.1 Statement of Purpose

The purpose of this study was to develop gain- and loss-framed messages that are targeted to young adults for the promotion of medication adherence and to assess the impact of those framed messages. This was accomplished via three specific aims. The first aim was to develop gain- and loss-framed messages informed by a qualitative synthesis of studies examining the experience of living with asthma as a young adult. The second aim was to assess the impact of framing on Beliefs, Intentions, Medication Adherence, and Asthma Control. The third aim was to examine the relationship between framing, Beliefs, Intentions, Medication Adherence, and Asthma Control.

1.4 Specific Aims

Specific Aim 1: To develop gain- and loss-framed messages for promoting medication adherence among young adults with asthma.

This aim had two purposes. The first was to identify asthma outcomes relevant to young adults. A qualitative meta-synthesis (systematic review of qualitative studies) was used to accomplish this purpose. The focused question for this review was "What is the experience of living with asthma as a young adult?" Outcomes of asthma relevant to young adults were identified from the review and subsequently used in the development of text messages. Three databases –CINAHL, PubMed, and PsycINFO– were searched from inception to March 2019. Additional articles were identified via a high sensitivity search on Google scholar up till March 2019. Eligibility criteria included qualitative and mixed method studies exploring the experiences of young adults living with asthma. A grounded theory approach was used in generating categories of outcomes of asthma relevant to young adults. The second purpose of

aim 1 was to develop gain- and loss-framed messages to be used in subsequent aims for promoting medication adherence decisions.

Specific Aim 2: **To examine the effects of gain- and loss-framed messages on Beliefs, Intentions to take medications, Medication Adherence, and Asthma Control.**

A randomized experiment was used in accomplishing this aim. Young adults were randomized to receive either gain- or loss-framed messages three times per week for eight weeks. Eligibility criteria of participants included being an emerging adult (18 – 29 years of age), ability to speak and write English, a diagnosis of asthma for at least 6 months, an active prescription of inhaled corticosteroids, enrollment at Auburn University, possession of a smartphone, and a willingness to receive text messages. Medication Adherence and Asthma Control measures were administered at baseline, week four, and week eight. Beliefs about medications and Intentions to take medication as prescribed were measured at baseline and at the end of the study. Participants' demographic information as well as their tendency to provide socially desirable responses were obtained at baseline.

Mixed design ANOVA was used in examining if Beliefs, Intentions, Medication Adherence or Asthma Control improved differentially from baseline between the two groups. We also assessed if all participants improved from baseline in all parameters (Beliefs, Intentions, Medication Adherence, and Asthma Control).

Specific Aim 3: To examine the relationship between Message Frame, Beliefs, Intentions, Medication Adherence, and Asthma Control.

A path analysis was used in examining the relationship between Message Frame, Beliefs, Intentions, Medication Adherence, and Asthma Control. The hypothesized relationships were

informed by the Theory of Planned Behavior. The independent variable was Message Frame while the dependent variables were Beliefs, Intentions, Medication Adherence, and Asthma Control.

1.5 Study Significance

There is limited literature on the health behavior of emerging adulthood. This study has a potential to contribute to knowledge about this cohort. A systematic review of experiences of young adults living with asthma revealed the unique impact of asthma on individuals belonging to this age group. Also, by targeting the intervention in this study to young adults, findings revealed the effects of message framing on the beliefs about medications, intentions to take medications, medication adherence, and asthma control of young adults. Findings may be adapted for interventions for young adults facing other chronic diseases.

This study had the potential to improve medication adherence to ICS among young adults as well as improve their asthma control through the use of message framing. Even though framing of information has been found to be effective in influencing judgments and decision-making, it has not yet been utilized in medication adherence efforts. Therefore, this study addresses an important gap in the literature. This study intended to tackle intentional nonadherence by utilizing message framing to communicate the health consequences of medication adherence or nonadherence to participants. Message framing was expected to promote positive decision-making (that is, decide in favor of taking medications as prescribed) among participants as well as impact their medication-taking behaviors. Framed messages were delivered via text messages to participants. By framing information on the health consequences of nonadherence, users were provided a basis for making a positive medication-taking decision. This intervention prompted

users to weigh the consequences of nonadherence versus adherence and was expected to consequently prompt users to make a positive decision about their medication-taking behavior.

Finally, there has been inconsistency in the field of health decision-making concerning the most effective types of message frames. Additionally, the role of an mHealth program utilizing framing to promote medication adherence among young adults has not been studied. The outcome of this study yields useful insight on utilizing message framing to promote medication adherence which may be adapted by pharmacy-based programs such as the medication therapy management program as well as in the general presentation of medication-taking information to patients.

1.6 Innovation

This study is innovative in five respects. First, there is no reported study that has examined adherence to ICS and asthma control in a diverse population of young adults. Second, there is no systematic review investigating the experience of young adults living with asthma. This study synthesized the literature on those experiences to identify the outcomes of asthma relevant to young adults. Third, there is no published literature examining the effect of message framing on adherence to medications (behavior) and asthma control (outcome) among any patient group. Fourth, no published study has investigated whether outcome expectancy (beliefs about the consequences of medication taking) is a mediator of framing on intentions to take medications. Fifth, no published study has assessed the relationship between framing, beliefs, intentions, medication adherence, and asthma control.

1.7 Organization of Dissertation

This dissertation consists of five chapters. The first chapter provides a background of the problem including the study's theoretical background. It also provides a brief description of the specific aims, a discussion of the study's significance and innovation. Chapter two presents an extensive review of the literature and the studies framework. Chapter three presents the research approach including the study design, participant recruitment, data collection, measures, and data analysis. It also describes the limitations, study timeline, specific aims, and hypotheses of the study. Chapter four describes the results obtained from the data analyses. Chapter five concludes the dissertation with a summary of findings, discussion of the results and implications for future study.

CHAPTER 2: LITERATURE REVIEW

2.1   Overview of Framing

Framing is a phenomenon whereby people make different choices when presented with identical information that are framed in different ways.[16] It is based on the work of Amos Tversky and Daniel Kahneman, known as Prospect Theory.[34] The theory postulates that when confronted with two choices – one that poses little risk and another that poses a higher level of risk— an individual's preference will depend on how the choices are framed. If the choices are framed to emphasize potential gains (gain-frame, e.g. lives saved), individuals will make the risk-averse choice. That is, they are less willing to take risk. Conversely, when choices are framed to emphasize potential losses (loss-framed, e.g. lives lost), individuals become risk seeking and are more willing to choose the risky option.

In the classical Asian disease problem, Tversky and Kahneman (1981) presented the following: Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease were proposed (Table 2.1). Students were required to choose either program A or B within each frame. Findings revealed a preference reversal with students being risk averse in the gain frame but risk seeking in the loss-frame.[34]

Table 2.1 Asian Disease Problem

Options	Problem 1 (Gain-frame)	Problem 2 (Loss-frame)
1	If program A is adopted, 200 people will be saved. [*72% chose this option*]	If program A is adopted, 400 people will die. [*22% chose this option*]

2	If program B is adopted, there is 1/3 probability that 600 people will be saved, and 2/3 probability that nobody will be saved. [*28% chose this option*]	If program B is adopted, there is 1/3 probability that nobody will die, and 2/3 probability that 600 people will die. [*78% chose this option*]

Since the work of Tversky and Kahneman, several studies have examined framing effects.[43,46,67-69] As a result, decision scenarios and decision frames different from the types used by Tversky and Kahneman have been utilized.[70] To address the resulting inconsistency in the relative persuasiveness of gain- versus loss-framed messages, Levin and Colleagues categorized framing into three categories – risky choice, attribute, and goal – based on what was framed, what was affected, and how the framing effect was measured (Table 2.2).[67]

Table 2.2 Classification of Framing by Levin and Colleagues (1998)

Type of Framing	What is framed	What is affected	How framing effect is measured
Risky choice	Set of options with different levels of risk	Risk preference	Comparison of choices for risky options
Attribute	Attributes of an event or object	Ratings of attractiveness of the item whose attributes were framed	Comparison of the ratings of attractiveness for the item
Goal	Outcomes of a goal or behavior	Adoption of a behavior	Comparison of the rate of adoption of the advocated behavior

Risky choice framing is the framing of a set of options differing in risk level either in terms of gain or loss.[34,67] According to this classification, the Asian disease study described by Tversky and Kahneman is risky choice framing, with the resultant effect on risk preference (choice of a riskless prospect or a risky prospect).[67,70] This type of framing may result in a choice shift or reversal such that gain frames yield risk-averse choices while loss frames yield risk-seeking choices.[67]

Attribute framing involves the framing of a specific characteristic or attribute of an event or object.[67] An example of attribute framing is, "The chances of developing incontinence is 1/3 when benign prostatic hyperplasia is treated medically," versus "the chances of not developing incontinence is 2/3 when benign prostatic hyperplasia is treated medically". The effect of attribute framing is on the ratings of the attractiveness of the item whose attribute was framed. For example, a recent study presented randomized participants to receive either a gain-framed or loss-framed description of a tourist destination.[71] Participants who received the gain-framed message had higher benefit expectations of the tourist destination.

In goal framing, the consequences or goal of a behavior or action are framed in positive or negative terms.[67] The effect of goal framing is assessed by comparing the rate of adoption of the advocated behavior. An example of goal framing is "If you obtain a flu shot this month, you increase your chances of enjoying the summer holiday without catching the flu" versus "If you fail to obtain a flu shot this month, you increase your chances of ruining the summer holiday by catching the flu". Gain-framing, loss-framing, and no framing were respectively applied to three different formats of a brochure recommending breast self-examination in a study conducted by Williams, Clarke, and Borland.[44] People who received the brochure format containing loss-framed recommendations exhibited greater positive change in breast self-examination.

2.1.1 Framing and Health Decision Making

People make decisions to perform health behaviors by considering the costs, or barriers, and benefits associated with the behavior.[53] There are a wide range of health behaviors that have been studied in the field of decision-making. This includes behaviors like sun-protection, mammography, testicular self-examination, physical exercise, smoking, and influenza vaccination. Detweiler et. al (1999) and Rothman et. al (1993) promoted positive decision making towards the adoption of sun protective behaviors to prevent skin cancer.[46,72] Participants who read information from gain-framed brochures were significantly more likely to request a sunscreen, as well as intend to use sunscreen, compared to those who read from loss-framed brochures.[72] In the study by Rothman et al, women who received a gain-framed pamphlet were significantly more likely to request for a free sample of sunscreen compared to those who received a loss-framed pamphlet.[46]

Meyerowitz and Chaiken (1987) investigated the most effective frame to improve breast self-examinations.[43] Loss-frames were more effective in yielding positive breast self-examination beliefs, intentions, and behavior compared to gain-frame and control. Rivers et al (2005) influenced positive decision-making towards pap-smear testing.[69] The authors found that when Pap smear testing was presented as a detection behavior, loss-framed messages were more effective in motivating women to obtain the test. Conversely, when Pap smear testing was presented as a prevention behavior, gain-framed messages were more effective.

Umphrey (2003) examined the effect of framed messages on persuading men to perform testicular self-examinations.[73] Men who were exposed to loss-framed messages and demonstrated a high depth of message processing had more positive attitudes towards performing testicular self-examination. Toll et al (2007) compared the effects of gain- and loss-

framed messages on utilizing Bupropion for smoking cessation.[74] Gain frame messages were more effective in encouraging smoking cessation. Frew et al (2014), promoted decisions to obtain influenza vaccinations among minority women.[75] Neither gain- or loss-frame messages were significantly associated with an increased likelihood of immunization.

Of the three types of message frames (risky choice, attribute, and goal) identified by Levin and Colleagues, attribute and goal framing are more applicable in health-decision making.[76] Goal framing may be used in persuading individuals to adopt a health behavior by describing the consequences of performing or failing to perform a health behavior. Conversely, attribute framing may be used to describe the characteristic of an object or event while risky choice framing describes a set of options with different risk levels. Apart from this, given the intention of this study to promote medication-taking via persuasion, goal framing is more relevant. Therefore, this study focuses on goal framing. According to Levin and colleagues, the most persuasive goal frame is the loss-frame.[67] This assertion is supported by a well-known study on breast self-examination which found that loss-framed information on the benefits of breast self-examination yielded more positive attitudes, intentions, and behaviors among participants compared to gain-framed information.[43]

Despite Levin's and Meyerowitz' findings, the findings of other studies involving health behaviors have been inconsistent. For example, studies utilizing goal-framed messages have found loss-frame to be more effective in improving breast self-examination, vaccination, and pap test utilization.[44,69,77] This is consistent with the findings of Levin and colleagues. Yet, other studies have also found gain frame to be more effective in promoting pap test utilization, alcohol use, exercise adherence, and sunscreen use.[69,72,78,79] Finally, studies have also found no loss or

gain-frame advantage on vaccination intentions or uptake in different populations, breast self-examination, and smoking cessation.[75,80,74,81]

2.1.2   Promoting Detection versus Preventive Health Behaviors

To explain the disparity of findings regarding the most effective framing approach, Rothman and colleagues categorized health behaviors as either prevention or detection behaviors.[82] Prevention behaviors are those behaviors which can prevent or help alleviate a health problem, while detection behaviors are those which can detect a health problem. Examples of prevention behaviors include smoking cessation, participating in physical activity, safe sex practices, eating a healthful diet, and receiving vaccinations.[16] Examples of detection behaviors include mammography screening, clinical skin examinations, blood cholesterol screening, breast self-examination, testicular self-examination, and conducting pap smear test.[16,69,73]

The risk level associated with each kind of behavior is different, with detection behaviors posing higher levels of risk compared to prevention behaviors.[82] This is because of the likelihood of an unfavorable finding with detection behaviors.[46] For instance, there is a likelihood of discovering the presence of breast cancer after obtaining a mammography screening. According to Prospect Theory, performing a prevention behavior is choosing a risk averse option because this option has little or no risk, therefore, gain-framed messages will be more effective.[46] Prevention behaviors are less risky because the essence of prevention behaviors is to maintain good health.[46] In a study on pap smear utilization, the gain frame – which emphasized the benefit of preventing cervical cancer – was more effective in persuading women to obtain a pap smear test when the test was presented as a prevention behavior.[69]

Alternatively, performing a detection behavior is choosing a risk seeking option because of the likelihood of an unfavorable finding.[46] Therefore, a loss-framed message will be more persuasive.[34] Banks et al, compared the differential effectiveness of gain- versus loss-framed messages on mammography utilization.[83] They found that women who viewed loss-framed messages were more likely to have obtained a mammogram within 12 months of the intervention. In a different study, loss-framed messages emphasizing the cost of not detecting cervical cancer early were more persuasive in motivating women to obtain a pap smear test.[69]

A meta-analytic review by O'Keefe and colleagues found that gain frames were more effective than loss frames in advocating disease prevention.[84] In a later review, they found a small, significant effect of loss-framed messages over gain-framed messages in persuading patients to undertake detection behaviors.[85] Also, a Cochrane review found that loss-framed messages led to greater perceptions of effectiveness of a detection behavior compared to gain-framed messages.[76] In terms of behavior, this review found little or no difference in behavior as a result of framing. A more recent review by Gallagher and colleagues found that gain-framed messages were more effective than loss-framed messages in encouraging preventive behaviors.[16]

In summary, existing literature indicates that detection behaviors such as mammography screening, blood cholesterol screening, and testicular self-examination are better promoted using loss-framed messages because of the likelihood of uncovering an unfavorable diagnosis.[46] This is explained by Prospect Theory which posits that people place a greater absolute value on losses more than gains of equal magnitude, and are willing to take greater risks when considering the potential losses afforded by their decision. Conversely, prevention behaviors such as medication adherence and participating in physical activity are better promoted using gain-framed messages

because the behaviors are relatively safe (they prevent the onset of a disease).[46] People act to avoid risks when considering the potential gain afforded by their decision.[86]

2.1.3 Moderators of Framing Effect on Health Behaviors

The classification of health behaviors as prevention or detection has suggested that gain-frames are more persuasive for prevention behaviors while loss-frames are more effective for detection behaviors.[82] [87]Yet, there are instances when studies fail to find significant differential effects between frames, except among a subset of the study participants as a result of moderators.[86] Apart from behavior type (prevention vs. detection), several moderators of framing effect have been identified, including issue involvement, perceived susceptibility, dispositional variation (motivational orientation and regulatory focus), perceived risks, and perceptions of certainty of the outcome.[88] [86,89,90] Each is explored in the following paragraphs.

Issue involvement: An individuals' level of involvement with an issue can affect how they respond and process information. Highly involved people process information in greater detail with a tendency to assign disproportionate weight to loss-framed rather than gain-framed information.[44,46,68,82] Maheswaran and Meyers-Levy (1990), confirmed their hypothesis that in a high involvement condition, loss-frame produced more positive beliefs and greater intentions compared to gain-frame, while in a low involvement condition, gain-frame produced more positive beliefs and greater intentions.[68]

Other studies have also investigated the role of issue involvement in relation to framing and its effects on attitude, intentions, or behavior. Although issue involvement did not moderate the effects of framing on breast cancer related beliefs and intentions in one study,[44] several studies support the findings of Maheswaran and Meyers-Levy (1990).[46,91,92] For instance, a study

promoting responsible drinking among college students found an interaction of issue involvement on framing effects.[92] Gain-framed information led to more positive attitudes and intentions among those with a low involvement, while loss-framed information led to more positive attitudes and intentions among those with a high involvement. It has been suggested that low involvement may lead people to rely on simple cues and heuristics for decision-making, with the positive affect accorded by gain frame resulting in greater compliance with advocated behavior.[82]

Perceived susceptibility: Perceived susceptibility, a construct of the Health Belief Model, refers to an individual's belief of their likelihood to develop a health condition. According to Updegraff et al (2015), people are more vigilant against the possibility of negative health outcomes when they perceive themselves as susceptible to that outcome. [93] A loss-frame is more effective in this scenario. Conversely, people with a low perception of susceptibility to a health condition are interested in achieving and maintaining positive outcomes, with gain-frame being more effective.[93] Updegraff and colleagues' assertion was confirmed by findings of gain-frame being more effective among those with low perceptions of susceptibility and loss-frame being more effective among those with high perceptions of susceptibility in persuading people to floss.[93]

Similarly, Williams (2010) found a greater increase in perceived susceptibility among those who received loss- compared to gain-framed messages.[44] Also, Umphrey (2003), found that loss-framed messages produced greater perceived susceptibility to testicular cancer compared to gain-framed messages in young college men.[73] Also, women with higher levels of perceived susceptibility for breast cancer were more likely to undergo mammography after viewing a loss-framed message compared to a gain-framed message.[94]

<u>Motivational Orientation</u> - Individuals differ in the extent to which they monitor for and respond to favorable and unfavorable consequences.[93] Some people are motivated to approach favorable outcomes (approach orientation) while others are motivated to avoid unfavorable outcomes (avoidance orientation). In a study promoting flossing, motivational orientation was not a significant moderator of framing effects on peoples' flossing behavior, although, it was significant for a subgroup of the study participants.[93] In this study, loss-frame was more effective for individuals in the avoidance orientation, while gain frame was more effective for individuals in the approach orientation. A similar study on flossing found that when given information in a loss-frame, people with an avoidance orientation flossed more whereas, when given information in a gain-frame, people with an approach orientation flossed more.[95]

<u>Regulatory Focus</u> – Regulatory focus theorists further explain the hedonic principle of approaching pleasure and avoiding pain through the regulatory focus theory.[96,97] The regulatory focus theory proposes that nurturance-related regulation (concern about attaining achievement and advancement) and security-related regulation (concern about safety and protection) differs in regulatory focus.[96] Accordingly, individuals who are more sensitive to the presence or absence of negative outcomes (security-related regulation) are prevention regulatory focused, while those who are more sensitive to the presence or absence of positive outcomes (nurturance-related regulation) are promotion regulatory focused.[90,96]

According to Cesario and colleagues, messages that are framed in terms of the pleasures of adhering to a recommended behavior should be more effective for promotion focused people, while messages framed in terms of the pains of non-adherence should be more motivating for people who are prevention focused.[90] They also demonstrated that messages describing the gain or non-gain information (presence or absence of positive outcomes) should be more effective for

promotion focused individuals while those that describe non-loss or loss information (presence or absence of negative outcomes) should be more effective for prevention focused recipients.[90,97] For example, antismoking messages lowered the likelihood of adolescents smoking when those with promotion focus received gain-framed messages and prevention focused people received loss-framed messages.[98] Also, an experiment promoting a regular consumption of fruit and vegetables found that the persuasiveness of framed messages was moderated by participants' regulatory focus such that the superiority of gain-framed messages in promoting prevention behaviors was less pronounced among those with a high preventive focus than those with a weak prevention focus.[99]

Perceived Risk: Studies have shown that the effectiveness of a message frame should depend on the risk that an individual associates with an advocated behavior rather than the features intrinsic to the behavior.[77,82,88] Several studies have provided support to the suggestion that perceived risk is a moderator of framing. Lee and Aaker (2004) argued that high perceived risk makes negative outcomes more salient while low perceived risk makes positive outcomes more salient.[97] They found support for their hypothesis. In their study, perceived risk of getting sunburned moderated the effects of framing with loss-frame being more effective than gain-frame among those with a high perceived risk of getting a sunburn. In this study, gain-frame was more effective for those with a low perceived risk.[97] In a separate study, perceived risk moderated the effects of framed messages intended to promote HIV testing.[100] The interaction resulted in loss-frame being more advantageous for people with some perceived risk in testing positive for HIV and gain-frame being more persuasive for those with low perceived risk.[100]

Perceptions of Certainty of an Outcome: While similar to perceived risk because of its focus on perceptions of probability, perceptions of certainty of an outcome differs in its focus on the

certainty of a behavior leading to an outcome, rather than perceptions of susceptibility to a condition.[87] O'Keefe and Jensen suggest that there is variability within the broad categories of prevention versus detection health behaviors based on perceived certainty of outcomes.[77,88] They suggest that although dental flossing, for instance, may be construed as a prevention behavior, it may be construed as a prevention behavior with a certain outcome. They argue that people are more likely to believe that good dental hygiene behaviors are very likely to prevent tooth decay. Whereas, people are more likely to think that the connection between exercise and heart attack risk is less secure or certain. O'Keefe and Jensen found that the consequences of dental hygiene behavior that were presented in a gain-frame were more persuasive compared to those presented in a loss-frame.[77] The authors propose that gain-frame is more effective in advocating or promoting preventive health behaviors that have certain outcomes versus behaviors with less certain outcomes.

2.1.4   Mediation of Framing Effects

In the field of decision making, very few studies have successfully delineated the mediators of effect of framing on people's decisions. Models of health behavior including the Health Belief Model, the Theory of Planned Behavior, and the Social Cognitive Theories suggest that several cognitive variables (e.g. intentions, perceived benefits, self-efficacy) may mediate the effects of framing.

The Health Belief Model is a conceptual framework used to explain changes and maintenance in health behavior.[53] Constructs of the model include perceived susceptibility (beliefs about the likelihood of getting a condition), perceived barrier (potential negative aspects of a health action which may act as an impediment to undertaking an advocated behavior), perceived benefits (perceived benefit of a recommended behavior), perceived severity (feelings

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of the seriousness of getting a condition or leaving it untreated), cues to action (cues that can trigger action), and self-efficacy (confidence in one's ability to take action).[53] Select constructs of the Health Belief Model (perceived susceptibility, perceived barrier, perceived benefits, and perceived severity) did not mediate the effects of framing on adherence to a cardiac rehabilitation program.[79] No published study has examined the effects of framing on adherence to ICS.

The Theory of Planned Behavior explains the variance in intentions to perform a behavior using the following constructs: attitude (a combination of an individuals' beliefs about an outcome of performing a behavior and the evaluation of that outcome), subjective norm (normative beliefs about the approval or disapproval of a behavior which is weighted by the individual's motivation to comply), and perceived control (beliefs of the existence of facilitating or constraining conditions weighted by beliefs about control over those conditions).[53] Attitudes, intentions, and perceptions of efficacy did not mediate the effect of framing in a study promoting flossing.[93] However, self-efficacy and intentions were mediators in another study promoting flossing.[95] Specifically, this study suggested that framed messages that were congruent with an individuals' disposition led to greater self-efficacy, stronger intentions to perform a behavior, and subsequently behavior change. The variation in findings on the mediation of framing effects by psychosocial variables is unclear.

Another influential theory is Social Cognitive Theory. Social Cognitive Theory posits that human behavior is the result of a dynamic interaction between personal, behavioral, and environmental influences.[53] It has nine constructs including outcome expectations (beliefs of the likelihood and value of the consequences of a behavioral choice) and self-efficacy. Self-efficacy, outcome expectancy, intentions, attitude, and perceptions of risk (perceived susceptibility to developing a condition) did not mediate the effects of framing on mammography use.[101]

Although framing was effective in persuading women to obtain mammograms, this study did not detect any influence of framing on the psychosocial variables (self-efficacy, outcome expectancy, intentions, attitude, and perceptions of risk). Similarly, perceived risk of breast cancer, self-efficacy, intentions, attitudes, beliefs, and emotional reactions (positive mood such as cheerfulness and negative mood such as sadness) did not mediate the effect of framing on mammography behavior.[83] Again, although these variables should mediate behavior change as suggested by different socio-cognitive theories, this study did not find any evidence supporting the mediation of the effects of framing on obtaining mammograms by the different variables.

However, self-efficacy mediated the persuasive impact of framed messages on breast self-examination.[43] Also, outcome expectancy mediated the effects of framing on vaccination intentions.[77] Self efficacy and outcome expectancy mediated participants intentions' to talk to a doctor about the Human Papilloma Virus (HPV) vaccine.[102] Specifically, perceptions of self-efficacy about talking to a doctor about HPV vaccine resulting from viewing framed messages increased participants outcome expectancy, which in turn produced greater intentions to talk to a doctor about the vaccine. Although intentions did not mediate the effect of framing on purchasing a dental hygiene product, it mediated participants request for free samples of the product.[87]

Framing effect occurs when people change preferences based on how a decision problem is framed – as a potential gain or loss. There are three types of framing: risky choice, attribute, and goal framing.[67] Goal framing is more relevant in promoting healthful behaviors because it persuades individuals to adopt an advocated behavior by describing the benefits (or cost) of performing (or failing to perform) an advocated behavior. The effect of gain- versus loss-framed messages has been studied on a wide range of behaviors. However, there are mixed findings on

the differential effectiveness of gain- versus loss-framed messages. Previous researchers have attributed this inconsistency to the type of framing, the type of health behavior (promotion versus detection), and the presence of moderators.[67,82,90] Socio-cognitive theories such as the Health Belief Model, the Theory of Planned Behavior, and the Social Cognitive Theory suggests that several psychosocial variables may mediate the effects of framing on behavior change. Previous studies have investigated the possible mediational role of several psychosocial variables including intentions, outcome expectancy, self-efficacy, attitude, and perceived risks. The current literature portrays a mixed evidence of the mediatory role of these variables on the effect of framing.

2.2   Medication Adherence

Medication adherence refers to the extent in which peoples' medication taking behavior corresponds with agreed upon recommendations by the healthcare provider.[30] However, patients do not always take their medications as prescribed. Patients may never fill a prescription (primary nonadherence) while some fill their prescriptions but do not take it regularly as prescribed (secondary nonadherence).[103] Patients do not take their medications as prescribed about 50 percent of the time.[30] In fact, a quarter of all prescriptions are never filled, and half of all medication-related hospital admissions are due to medication non-adherence.[104,105] Poor adherence to medications is responsible for substantial worsening of disease, death, increased hospitalization, and increased healthcare costs.[106,107] Indeed, the yearly cost of medication nonadherence to the US healthcare system is about $300 billion.[108] Per person, the economic cost of medication nonadherence ranges from $949 – $44,190.[109] Lower levels of adherence are associated with higher total costs (pharmacy, inpatient, medical, emergency department, and hospitalization costs) in a 12-month analysis period.[106] Also, patients who maintain an adherence

level of 80 – 100% are less likely to be hospitalized compared to patients with lower adherence levels.[106] Additionally, a recent meta-analysis of observational studies found a strong association between adherence and lower mortality rates.[110]

2.2.1 Measures of Medication Adherence

Measures of adherence are categorized as direct and indirect. Direct measurement occurs when the concentration of a drug, its metabolite, or a biomarker is measured in patients' blood or urine. Indirect measurement includes diverse methods such as pill counting, electronic pill bottles, dose-delivery devices, patient self-report, and rates of prescription refills.[30,103] Both direct and indirect measures have advantages and disadvantages and none can be considered a perfect measure.[111] Some measures of adherence include:

<u>Patient Self-Report:</u> Self report measures include self-administered questionnaires and diaries. They are preferred when speed and low cost of administration are desired.[112] However, self-reported adherence data are susceptible to manipulations by patients, recall bias (errors that occur as a result of inaccurate recollection of medication-taking by patient), and social desirability bias (the likelihood of a patient to overestimate adherence to please a doctor or other providers).[30,112] Indeed, patients overreported their adherence to asthma medications via self-report with electronic measures and canister weights being more accurate in one study.[113]

Despite the limitations of self-report measures, they have demonstrated moderate correspondence to other adherence measures and can predict clinical outcomes significantly in some conditions.[112] A review of 77 studies on self-reported adherence to antiretrovirals found that self-reported adherence was significantly associated with viral load.[114] Methods to improve the accuracy of self-report include: the use of validated scales, measurement of social desirability

bias (in order to control for it), optimizing response options and recall periods, and assessing the right constructs.[112] The Medication Adherence Rating Scale for asthma (MARS-A) is a validated measure of medication adherence for patients with asthma.[31]

Rates of Refill: This measure assumes that prescription medication refill behavior corresponds with medication-taking behavior.[111] Typically, electronic prescription information from secondary databases is used in calculating adherence. This measure of adherence is accurate in closed pharmacy systems if the refills are measured at several points in time.[30] Secondary database analysis can be used in calculating adherence measures such as the proportion of days covered (proportion of days in the measurement period covered by prescription claims), medication possession ratio (percentage of days' supply obtained over a refill interval), and the continuous measure of medication gaps (total number of days in treatment gap over a measurement period).[111] The disadvantage of using refill rates to calculate adherence is that patients may use multiple pharmacies and refills do not equate to usage.[103]

Pill-Counts: Pill counts are an indirect but objective measure of adherence in which the number of medication dosage units taken between two clinic visits are counted.[111] However, counting inaccuracies are common and usually result in an overestimation of adherence.[103] Other problems with pill counts is the tendency of patients to switch bottles or discard pills before visits to appear adherent.[30] Pill counts are not informative so far as medication taking pattern (e.g. timing of medication taking) is concerned.[111]

Electronic Monitoring: A modern way of monitoring medication taking that is similar to pill count is electronic monitoring. Features of electronic monitoring include recorded dosing events and stored records of adherence; audiovisual reminders, digital displays, real time monitoring, and feedback on adherence.[111] Examples of electronic monitoring devices include the Medication

Events Monitoring System (MEMS) and electronic sensors in inhaler devices for asthma medications.[111,113] Although electronic monitoring devices are useful ways of measuring adherence, they are expensive with a potential for device loss and technical problems.[103,111] These devices also have a potential of being manipulated leading to misleading adherence information.[111]

Direct Measures – Measuring the levels of a drug, its metabolite, or a biomarker is a commonly used approach for certain drugs such as phenytoin, an antiepileptic.[30] This method is cumbersome for healthcare providers because providers or technicians are required to monitor the drug metabolism process as well as conduct the tests to assess adherence.[111] Ablify MyCite, an oral dosage form with embedded sensor, has the ability to track medication ingestion.[115] This technology may be a less cumbersome method of directly tracking adherence because after the medication has been ingested, the information is transmitted to an app for tracking. Although direct measures are considered the most accurate, findings may be misleading and are influenced by individual factors such as absorption and excretion rates.[103] Direct methods are also expensive, and bias may be introduced if patients only take medications prior to a test, for instance.[111]

2.2.2   Barriers to Medication Adherence

Nonadherence is a complex problem with many causes. The World Health Organization (WHO) organizes factors related to medication nonadherence into 5 categories: socioeconomic factors, condition-related factors, therapy-related factors, patient-related factors, and system-related factors.[103]

Socioeconomic Factors: Numerous socioeconomic factors that affect patients' medication-taking behavior have been identified. These include practical social support, emotional support, unidimensional social support, family cohesiveness, being married or living with someone, education, age, illiteracy, employment, unstable living conditions, cost of medications, and beliefs about illness and treatment.[103,116-118] The presence of social support (practical, emotional, or unidimensional), family cohesiveness (e.g. family acceptance, warmth, closeness), and being married or living with someone increase the odds of adherence.[119] Conversely, conflict in the patients' home is associated with an increased odds of nonadherence.[119] Income and socioeconomic status are positively correlated with adherence.[120] Demographic variables are also associated with adherence with older age, more education, and full time employment, being associated with better adherence.[117,118]

Condition-Related Factors: These factors are condition-related demands, including those related to severity of symptoms, diagnoses or disease, level of disability, rate of progression, severity of disease, and availability of effective treatments.[103] For instance, a review of the determinants of adherence reported that patients who were judged to be in poorer health by their physicians were more adherent to their medications.[116] A review of the literature by Dimatteo (2004) found that patients with a diagnosis of HIV, cancer, and gastrointestinal disease were more adherent compared to conditions such as sleep disorders and pulmonary conditions.[120] In another study, patients who have had inflammatory bowel disease for less than five years were significantly less adherent compared to those with longer-standing disease.[121] Medication adherence can be influenced by comorbidities and substance abuse (e.g., smoking).[103] In one study, smokers were less likely to be adherent to their medications compared to non-smokers or past smokers.[118]

Therapy-Related Factors: Complexity of medical regimen, duration of treatment, previous treatment failures, and side-effects are examples of therapy-related factors.[103] Patients are more adherent to daily dosing (compared to twice a day dosing), and with flexible dose strategies (compared to fixed dose strategies).[116] In one study looking at the factors influencing adherence to multiple sclerosis treatment, nonadherence was linked to pain at injection sites, injection-related anxiety, and skin reactions.[122] In another study, patients that were treated for inflammatory bowel disease with oral medications were significantly more adherent compared to those receiving rectal medications.[121] Swallowing difficulties, nausea, and multiple doses were reported reasons for not taking oral doses while bloating and difficulty with administration at work were reasons for not taking rectal doses.[121] A prospective cohort study exploring associations with nonadherence found that anti-asthmatics were associated with higher intentional nonadherence.[123] This finding indicates that patients on asthma medications mostly fail to take their medication as a result of a deliberate decision.

Patient-Related Factors: These factors include the resources, attitudes, beliefs, perceptions, expectations and knowledge of the patient.[103] Having a poor understanding of the disease, inadequate knowledge and skill in managing disease symptoms and treatment, low outcome expectancy (low belief in the effectiveness of medication), disbelief in the diagnosis, lack of perceived need for treatment, low motivation to take medications, fear of dependence on medications, and depression are all associated with nonadherence.[30,103,116] Studies have found that patients who were depressed were more likely to be nonadherent.[116,122,123] Also, seeing a condition as a threat or potentially fatal (due to perceived severity) increased patients' odds of adherence.[116] A patient's motivation to take medications as prescribed is influenced by the value that the patient places on taking the medication (outcome expectancy) and the degree of

confidence in being able to take the medication as prescribed (self-efficacy).[103] For instance, multiple sclerosis patients who were more adherent to their medications were more likely than less adherent patients to believe that treatment was beneficial.[122]

System-Related Factors: Healthcare systems create barriers to patients' medication taking by limiting access to care, using a restricted formulary, overworking healthcare providers, not providing training to healthcare providers on how to manage chronic conditions, and not providing patient education.[30,103] The degree of communication between patient and provider is determined by the health system. For instance, patients who communicated more with their physicians were more adherent compared to those who did not communicate with their physicians.[121] Similarly, multiple sclerosis patients who listed their physicians as their strongest source of support were more adherent.[122] Whereas, lack of trust in physicians and healthcare is associated with nonadherence.[116] In one study looking at primary nonadherence, medications that were not covered by insurance were rarely filled while preferred or on-formulary medications were filled more.[105]

Provision of training for providers on how to educate or counsel patients and incentives to encourage patient education are determined by health systems.[103] This is important since patient education has been linked with adherence.[30] Furthermore, health systems are responsible for scheduling the workload of providers.[103] Overworking of providers is associated with decreased adherence.[103] Health systems are also responsible for formulary development and maintenance. A lack of coverage for medications used by the patients has a negative impact on medication adherence.[124]

2.2.3 Medication Nonadherence Among Asthma Patients

Treatment for asthma combines two approaches: the use of reliever medications (e.g., albuterol) to relieve symptoms of acute exacerbation, and the regular use of controller medications (e.g., mometasone) to prevent the likelihood of an attack.[27] Reliever medications are to be taken only when needed, not regularly.[125] The mainstay controller medication is the inhaled corticosteroid (ICS), including budesonide, fluticasone propionate, beclomethasone, mometasone, and cicleosonide, which may be given alone or in combination.[27] The rates of adherence to ICS are low; a recent review reports that adherence to ICS is less than 50% for adolescents and adults.[126] In one study, half of the asthma patients refilled a 30-day prescription only once in 12 months.[12] Poor adherence to ICS leads to poorly controlled asthma, with resultant clinical consequences (e.g. exacerbation), economic consequences (e.g., increased healthcare utilization), and humanistic consequences (e.g., decreased quality of life).[103]

The economic consequences of uncontrolled asthma are immense. The US spends over $80 billion annually on asthma-related cost including absenteeism and mortality.[127] In one study conducted with a state level insurance claims database the cost of asthma as a result of reduced productivity and time lost from work ranged from $1,255 and $2,832 per person per year.[128] A national study of the economic burden of asthma found the medical cost per person is higher at $3,266, which includes the cost of prescriptions, office visits, hospitalizations, outpatient visits, and emergency department care.[127] In terms of asthma-related deaths, the US spends $29 million per year.[127]

Research has demonstrated that adherence to ICS may help reduce asthma-related care utilization, costs, and death.[129-132] A retrospective study of over 70 US health plans using pharmacy and medical claims found that an increase in adherence to an ICS combination by a

quarter was associated with a 10% reduction in the odds of asthma related ED visit or hospitalization, a 10% reduction in the odds of receiving a reliever medication, and a 3% reduction in the odds of receiving corticosteroids.[130] Also, regular use of ICS was associated with reductions of 31% and 39% for rate of hospital admissions and rate of readmission on account of asthma, respectively.[131] Rust and colleagues found that increasing the number of children who were adherent to ICS to 40% and 80% would result in cost savings of $8.2 million and $57.5 million, respectively.[132] Apart from cost and healthcare utilization, other consequences of poorly controlled asthma include an increased risk of anxiety and depression, lower cognitive function and educational attainment, obesity, and poor physical fitness.[9,10]

Asthma patients experience several barriers in asthma management. A closer look at the barriers of asthma management may help to clarify why patients are nonadherent to ICS. Patients who believe that asthma is not serious or chronic disregard the importance of asthma symptoms and do not take their medications as prescribed.[66] Some patients do not take their ICS as prescribed because of a fear of dependence or addiction to controller medications. Patients have reportedly assumed that daily use of a medication would lead to a need for increased dosage based on a belief that the effectiveness of medications decreases over time.[66] Patients with inadequate knowledge about their medications are concerned about their drug interacting with other drugs or may be unsure of the technique of administering a dose.[23] Fear of adverse events, belief that the medication is not helpful or necessary, forgetfulness, and lack of motivation were perceived by patients as reasons for nonadherence to ICS.[13,66] A preference for non-pharmacologic approaches, and a preference for a restriction of physical activities instead of taking medications were reported by patients who had an untoward feeling towards taking traditional medicine. Furthermore, young adults have self-reported inconvenience of medication

use, interference of asthma management by life responsibilities, and cost of medication as a barrier to asthma management.[23] Misbelief or lack of a clear diagnosis have also been reported by asthma patients who doubted their diagnosis.[66] Such patients do not believe that they need to take ICS.[66] Lack of a formal or objective assessment of disease severity, insufficient explanation of asthma and its management, poor patient-physician relationship, and a lack of a patient-centered approach to care have also been reported as barriers with resultant hesitation in taking medications or outright refusal to take a long-term controller medication. [64] Its been reported that asthma patients complain about having to rinse their mouth after taking a dose of ICS, having to use two inhalers, and difficulty in determining whether a full dose was taken.[126] Asthma patients have reportedly stretched the doses of their ICS to make it last longer due to cost.[126]

In a multivariate analysis of questions related to patients' acceptance of asthma medications, response to three questions were significantly associated with nonadherence.[49] These include, efficacy beliefs (response to, "I am not sure inhaler type medicines work well"), inconvenience (response to, "Taking medicines more than once a day is inconvenient"), and cost concerns (response to, "Sometimes I skip my inhaler to use it over a longer period"). A recent review on barriers to asthma self-management reports that patients commonly expressed frustration over the relationship with their providers.[133] This study also reported patients expressed a concern over the safety and side effects of asthma medications. This includes a concern over tolerance and addiction as a result of asthma medication use. A summary of barriers unique to asthma management are listed in Table 2.3.[13,23,66,134]

Table 2.3 Barriers Unique to Asthma Management

#	Barriers	#	Barriers
1	Belief that asthma is not serious	8	Preference for non-pharmacologic treatment of asthma
2	Belief that asthma is not chronic	9	Inconvenience of asthma medication use (e.g. of using inhaler in the presence of others)
3	Fear of dependence on asthma medications	10	Misbelief of an asthma diagnosis
4	Perceptions that treatment of asthma should be in response to symptoms	11	Lack of a clear diagnosis of asthma
5	Belief that asthma medications are not helpful	12	Preference for non-pharmacologic treatment of asthma
6	Belief that asthma medications are not necessary	13	No formal assessment of asthma severity
7	Insufficient explanation of asthma and its management		

2.2.4 Intentional vs. Unintentional Nonadherence

Nonadherence is categorized as intentional nonadherence, which follows an active decision of the patient, and unintentional nonadherence, which involves nonadherence due to a passive process that is less strongly associated with an individual's cognition and beliefs.[25,135] A study by Wroe demonstrated that intentional nonadherence is predicted by a balance of an

individual's reasons for and against taking a medication.[135] This study also found that unintentional nonadherence is not strongly associated with decision-making but more associated with demographics such as age, gender, and ethnicity.[135] Reasons for unintentional nonadherence could be forgetfulness, misunderstanding the regimen, incorrect device technique and language barriers.[25,136]

Studies have reported intentional and unintentional nonadherence among asthma patients.[65,137] Laforest and colleagues found that 31.6% of asthma patients intentionally adjusted their dose when they felt better (intentional nonadherence), 25.4% forgot to take their medications (unintentional nonadherence), and 18.3% deliberately changed the dose (intentional nonadherence).[65] In another study of 67 people who reported nonadherence, 30 provided reasons that were deemed intentional while the remaining 37 people gave reasons that were deemed unintentional.[137]

A critique to this approach of classifying nonadherence is the failure to capture unconscious mental processes or the irrationality in human decision-making.[25] Indeed, heuristics or mental shortcuts, a concept that stems from the presence or lack of information, can lead to patients over-estimating (optimistic bias) or underestimating the risk involved with a condition.[25] Wroe addresses the influence of heuristics in decision making when she asserted that in the situation of intentional nonadherence, patients are likely to focus on reasons to either take or not take their medication hence making their decision to appear irrational.[135]

Other researchers have proposed that adherence decisions are influenced by an interaction of personal beliefs about the necessity of the drug and concerns about the side effects of adhering to the medication.[137,138] Indeed, findings from several studies have supported the different types of nonadherence. Horne and Weinman (2002) found that patients who had a

strong belief about the necessity of their medication where more adherent, while those who reported greater concerns about side-effects were more likely to be nonadherent.[138] Clifford and colleagues found similar results with intentionally nonadherent individuals possessing lower perceptions of the necessity of their medication and higher concerns about side-effects compared to adherent individuals.[137] In all, intentional nonadherence is a result of an active decision of a patient, which is informed by their beliefs. A focus on reasons that are relevant to the patient during the decision-making process may make their decision to appear irrational. Unlike intentional nonadherence, unintentional nonadherence is less associated with decision-making.

2.3 Asthma Control

According to the Global Initiative for Asthma (GINA), all patients diagnosed with asthma may be managed by a long-term controller medication, typically, an inhaled corticosteroid (ICS).[125] GINA recommends a regular low dose ICS for all patients diagnosed with asthma with any of the following symptoms: 1) asthma symptoms more than twice a month, 2) waking due to asthma more than once a month, and 4) the presence of any asthma symptom together with a risk factor for exacerbation.[139] The guideline used in the US is the National Asthma Education and Prevention Program's Expert Panel Report 3 (EPR-3).[1] According to EPR-3, initiation of therapy should be informed by the severity of asthma and patients with persistent asthma should be maintained on a controller medication.[1] A low dose ICS has several benefits including halving the risk of asthma related deaths and a reduction of the risk of hospitalization.[129,131] Indeed, several large scale studies have shown the safety and efficacy of ICS in improving asthma control.[140,141]

However, patients do not take their medications as prescribed. In fact, 50% of patients prescribed an ICS for the long-term management of asthma do not take their medication as

prescribed.[142] Nonadherence contributes to increased risks of exacerbation and health service utilization.[108,132,143] Research has shown that a focus on disease severity rather than control contributes to nonadherence.[144] Therefore, the strength of the current GINA / EPR-3 guideline includes a shift of focus from disease severity to asthma control, emphasis on patient-provider relationship, patient education, and consideration of patient preferences.[145]

The control of physical symptoms and the prevention of adverse health outcomes is the aim of asthma management.[125] The approach of managing asthma has shifted from severity-based management to a control-based management which involves a continuous cycle of assessing symptoms, adjusting treatment, and reviewing response to ensure the maintenance of asthma control.[139] Although there are several tools for assessing asthma control, the two numerical tools mentioned by the GINA include the Asthma Control Test (ACT) and Asthma Control Questionnaire (ACQ).[146] The ACT is a reliable, valid, survey instrument for measuring asthma control based on a four week recall period.[32,33] The instrument consists of five questions on shortness of breath, nighttime symptoms, rescue medication use, work or school impairment, and patient rating of asthma control in the past four weeks. Each question is scored from 1 to 5 and are summed to obtain the final score.[8] A cut-off score of 19 or less identifies patients with uncontrolled asthma,[33] while scores of 20 to 25 are categorized as well controlled asthma. The minimum clinically important difference is three points for the ACT, which means that a difference in ACT scores of at least three points reflects a clinically significant change regardless of beginning and ending score.[147]

The ACQ is also a valid and reliable questionnaire for assessing asthma control.[148] The ACQ consists of seven questions. Of those, five are symptom questions regarding nighttime awakenings, symptom severity on waking, activity limitation, shortness of breath, and wheezing

within the past week. The remaining questions asks about rescue medication use and pre-bronchodilator forced expiratory volume (FEV_1). Each question is scored from 0 to 6, with greater scores indicating worse symptoms. The average of all items produces the overall score. A score of 0.0 to 0.75 is considered well-controlled asthma; 0.75 to 1.5 is considered the grey zone; while greater than 1.5 is considered poorly controlled asthma.[125] The minimum clinically important difference for ACQ is 0.5.[148] In terms of identifying those with controlled asthma (specificity) and those with uncontrolled asthma (sensitivity), the ACT and ACQ perform differently. According to a recent study comparing the two instruments, the specificity of ACQ and ACT were 57% and 70%, respectively.[149] Also, the sensitivity of ACQ and ACT were 88% and 94%, respectively.[149]

In a study assessing the effectiveness of a multicomponent technology-based intervention (computerized motivational interviewing sessions followed by text messages) on the adherence to ICS by African-American emerging adults, the intervention group had a larger magnitude of improvement in ACT scores compared to the control group at the end of three months.[15] Britto et al, explored the use of text messages to improve asthma control among adolescents and young adults.[64] Asthma control measured with the ACT improved significantly from baseline to the end of month 1. A cross-sectional, observational study of adult patients with asthma utilized the ACT to measure asthma control.[49] In this study, the mean ACT score was 20 +/- 4.5 and 64% of the participants had well-controlled asthma.[49] To explore the effectiveness of bronchial thermoplasty in the treatment of asthma, Castro et al measured asthma control with the ACQ.[150] Participants in the two study groups (bronchial thermoplasty versus sham [fake bronchoscopy] procedure) showed improvements in asthma control from baseline. However, the difference was not statistically significant.

2.3.1. Young Adults and Asthma Management

Emerging adulthood (young adults) include individuals between the ages of 18 and 29.[151] This developmental period is characterized by five main features: identity explorations, instability, self-focus, feeling in-between adolescent and adulthood, and age of possibilities.[19] It is important to assess the implication of each feature as it pertains to disease management to help understand how this unique developmental phase contributes to adherence to asthma medications and asthma control.

1. Identity Explorations: This is a time when young adults explore who they are and what they want out of life.[20] Young adults seek to know who they are as individuals by answering questions about their abilities and interests.[20] The literature has demonstrated that asthma interferes with social relationships, career choices, hobbies, and physical activities.[6,23] It is therefore plausible that the morbidity associated with uncontrolled asthma may interfere with young adults trying out new things and exploring what they like and the kinds of friends they prefer to be with. In terms of how identity may affect medication management, research is limited. However, Speck and colleagues found that young adults desire to fit in with peers and not stand out because of asthma.[23] This desire to not differ from peers could serve as a barrier to medication taking among young adults.

2. Instability: Emerging adulthood is a time when young adults typically move away from families, and their school and work patterns are relatively unstable.[20] Young adults are known to change majors in school, work multiple jobs to pay bills, and shift choices in relationships, as well. Due to limited research on emerging adulthood, questions persist on the effects of residential, school, and work instability on the asthma management behaviors of young adults. However, transitions in employment, college status, or family

structure causes disruptions in insurance coverage, limiting their access to care.[21] Health

insurance lapses are a barrier to consistent medication-taking among young adults with

asthma.[13,23] Although the Patient Protection and Affordable Care Act (ACA) has helped,

uninsurance among emerging young adults persist,[152] contributing to nonadherence to

asthma medications among this population.

3. <u>Self-Focus:</u> Social networks and relationships that impose a type of social control over

individuals are less influential during this developmental period, with the exception of

friends.[19] As a result, young adults are typically free from daily obligations to others,

allowing them to make decisions independently without any requirement to get the

consent or permission of others.[20] Indeed, young adults equate being independent with

being an adult.[13,151] This independence has disadvantages in terms of disease

management. Specifically, perceptions of independence among young adults includes

making decisions about taking their controller medications (when and how much),

regardless of prescribed regimen.[13] Studies have also reported that young adults with

asthma mostly believe that when they are asymptomatic, controller medications are not

required.[23,24] Indeed, young adults are mostly nonadherent to their controller medications

based on a conscious decision (intentional nonadherence).[13] Even when young adults

indicate that they forgot to take their medications, further probing has revealed that they

actually did not intend to take the medication.[13]

4. <u>Feeling in Between:</u> In a study that explored transitions to adulthood, young adults

mostly responded "neither yes or no" to the question "Do you feel that you have reached

adulthood?"[151] From the perspective of young adults, markers of adulthood are not

comprised of educational attainment, marriage or parenthood, but rather intangible

psychological qualities such as accepting responsibility for oneself, making independent decisions, and being financially independent.[20,151] In the field of substance abuse, Arnett (2005) proposed that emerging adults who feel that they were not yet adults would be more likely to use substances inappropriately.[20,151] In terms of asthma, it is not clear whether feelings of not having reached adulthood increase the likelihood of non-adherence to asthma medications.

5. Age of possibilities: Emerging adulthood is considered the age of possibilities for two reasons. First, this period represents a season when people have opportunities to make dramatic changes in their lives such as leaving home and creating a healthier life. Second, it represents a season of universal optimism with young adults believing that life will eventually work out despite any prevailing circumstance.[19] Indeed, young adults are susceptible to optimistic bias about the negative consequences of poor asthma management by not taking needed ICS as prescribed.[13,20]

The challenges associated with young adulthood must be considered in understanding the medication taking behaviors of young adults as well as in developing relevant interventions. Interventions to improve medication adherence among young adults are critical given their poor disease management skills, increased risk-taking behavior, and susceptibility to optimistic bias.[11,13,17,152]

2.4 The Role of mHealth on Medication Adherence

Mobile Health (mHealth) is the use of mobile devices such as mobile phones for medical and public health practice.[61] mHealth may be a viable option for promoting adherence among young adults because mobile phones are very prevalent among young adults.[153] A Pew Research Center study found that nearly 100% of young adults in the US, ages 18 to 29, own a cellphone,

94% of which are smartphones.[153] Smartphones are phones that have capability for installation of phone-based applications and serve other functions including GPS-based navigation, and playing media.[154] The widespread use of cellphones suggests the viability of using mHealth to engage young adults in their health including asthma. Smartphones have been used for tracking personal data, accessing healthcare providers, connecting to an online community, patient monitoring, education, decision support, disease surveillance, and for promoting medication adherence.[61,155]

mHealth interventions are acceptable and helpful to young adults. Studies across diverse conditions have reported the acceptability and helpfulness of diverse mHealth interventions including text messaging, self-management apps, audiovisual response devices, and pagers in promoting adherence to ICS.[15,64,156] Adolescents and young adults provided a high rating on the acceptability of a text messaging intervention aimed at improving asthma outcomes.[64] Young adults rated a multi-component technology-based program intended to promote adherence to ICS favorably. A review of digital interventions for asthma including video games, interactive voice response, and web based interventions found a high user satisfaction with the interventions.[157] Studies have also reported young adults' preference for mHealth tools in asthma management programs.[15,23] However, these studies are homogeneous, focusing on a specific subset of young adults (African-Americans).[15,23] There is a need to understand the specific needs and preference of a more diverse young adult population for mHealth interventions.

mHealth studies yield mostly positive results. Receiving text messages resulted in a 2.75% increase in adherence per month among young adults and adolescents with asthma, relative to control ($p < 0.01$).[64] This intervention also impacted participants' asthma control and worry about asthma. Specifically, their asthma control improved and the worry about asthma decreased.[64] A review by Tran and colleagues suggests that reminding patients to take their ICS

using mHealth technologies like text messages and audiovisual reminders is effective.[156] Electronic devices with audiovisual reminder functions were effective in improving adherence to ICS among intervention participants relative to a control group in two different studies.[158,159] None of these studies were focused on young adults. Text messaging interventions effectively increased adherence to inhaled corticosteroids in two different studies.[160,161] Again, the interventions were not intended for young adults. One of the studies included adults between the ages of 18 and 45,[160] while the other consisted of adults between 16 and 45.[162] One of the studies employed daily text messaging,[160] while the other study varied frequency of texting from two texts per day to three text per week.[162]

Furthermore, a recent systematic review specifically focused on mHealth interventions found that mHealth had moderate to large effects on adherence to ICS and asthma outcomes compared to usual care.[62] However, the research question was not focused on young adults. Additionally, psychological concepts like framed messages were not utilized in the interventions. Clearly, mHealth has potential to promote medication adherence among young adults with asthma. Yet, the effect of delivering framed messages via text messages on young adults' beliefs, intentions, adherence, and asthma control is unknown. This study proposes to deliver framed messages to young adults enrolled in college.

2.4.1 Young Adults' Preferences for a Text Messaging Intervention

Text messaging is increasingly popular among young adults. On average, young adults in the United States send and receive over 128 texts every day.[163] Furthermore, young adults have indicated a preference for text messages in interventions promoting behavior change, including medication adherence.[23] Specifically, they find a texting intervention that does not repeat messages, sends messages that are sufficiently detailed, and relevant to be appealing. Young

adults have also reported a preference for text messaging interventions delivered twice daily and once daily, with a preferred delivery period between 10am and 7pm.[13,15,164] However, in one study consisting of mostly young adults, some participants specifically mentioned the undesirability of receiving messages in the weekends.[165] In terms of content, asthma patients in general prefer messages that remind them to take their medications, refill medications, educate on asthma, or suggest a cue to action such as to refill medications.[166]

2.5 Theoretical Framework

This study is based on the Prospect Theory (a theory of decision-making), while the conceptual model is based on the Theory of Planned Behavior, a socio-cognitive theory. Prospect theory is concerned with how individuals' choices, preferences, attitudes, and behavior may be influenced based on the presentation of information.[34] It posits that individuals consider the outcome of their decisions as gains and losses relative to their current wealth.[34] Socio-cognitive theories describe the key variables and interrelationships that predict health behaviors. Interventions with greater evidence in improving adherence to medications are grounded in socio-cognitive theories.[53] The conceptual model of the present study is based on the Theory of Planned Behavior.

2.5.1 Prospect Theory

Individuals consider the outcome of their decisions as either gains or losses.[35] These gains and losses are usually considered relative to a reference point, which corresponds to the current asset position of the individual.[35] Prospect Theory posits that people are risk averse in the domain of gains, and risk seeking in the domain of loss.[35] In other words, people act to avoid risk when considering gains but are willing to take risks when considering losses. Prospect Theory

explains why a long-standing theory: the Expected Utility Theory, which suggests that people make decisions based on the probability of the associated outcomes, does not behaviorally occur when people evaluate prospects.[34] Based on the Expected Utility Theory, when confronted with a decision problem, individuals will prefer the option that offers the highest utility value.[34] However, Tversky and Kahneman have demonstrated that people change their choices or preference based on how a decision problem is framed.[34,35] A classic example is the Asian disease problem (Table 2.1) in which a choice reversal was witnessed based on how the choice options were framed. Published studies examining the effect of framing on adherence to asthma medications could not be found. The effects of framing on health decision-making has been discussed in section 2.1.1.

2.5.2 Theory of Planned Behavior

The Theory of Planned Behavior has been successfully used in predicting a wide range of health behaviors including adherence to medications.[47,167] According to the Theory of Planned Behavior, intentions, a construct that is informed by attitudes, beliefs, and perceived control of a behavior, is the best predictor of behavior (Figure 1.2).[47,168] Intentions is an indication of how willing people are to try or how much of an effort people are willing to exert, to perform a behavior.[47] The stronger the intentions to perform a behavior, the more likely it is that the behavior would be performed.[168]

The attitudinal component is comprised of behavioral beliefs – defined as the subjective beliefs that a behavior will produce an outcome – and attitude towards a behavior – defined as the degree to which performing a behavior is positively or negatively valued.[168] For example, if a person has strong beliefs that taking asthma medications is good and leads to favorable

outcomes, then he or she would be more likely to have a positive attitude towards taking the medications.

Subjective norm is the second construct that influences intentions. Subjective norm is comprised of normative beliefs and motivation to comply.[47] Normative beliefs are beliefs of the likelihood that important referent individuals (e.g., parent, friend, or partner) approve or disapprove of performing a given behavior.[168] Motivation to comply represents how much an individual cares about the approval or disapproval of a behavior by a referent other.[47]

Finally, perceived behavioral control influences intentions as well. Perceived behavioral control refers to peoples' perceptions of control over a behavior, perceptions of difficulty of engaging in a behavior, and perceptions of their self-efficacy in performing the behavior.[47,80] The more resources and opportunities people think they have, and the fewer obstacles they anticipate, the greater their perceived control should be.[47]

The more favorable a person's attitude towards a behavior, the more favorable the subjective norm, and the greater the perceived behavioral control, the stronger the intentions to perform the behavior is likely to be.[168] No published study has examined the Theory of Planned Behavior in the context of predicting patients' adherence to ICS. One study utilized the Theory of Planned Behavior to explore the behavioral influences, motivation, and self-efficacy that guides patients' decision to fill asthma prescriptions.[48] Specifically, responses to questions informed by the Theory of Planned Behavior were compared between those who refilled versus those who did not refill their controller medications. In this study, people who did not refill their controller medications differed from those who refilled based on their perceived medication importance (behavioral beliefs). Unexpectedly, those who did not refill had more positive beliefs about the importance of taking the ICS. They reported more strongly that their inhalers were

important. According to the Theory of Planned Behavior, behavioral beliefs informs intentions to perform a behavior while intentions inform behavior. The present study examines the effects of message framing on young adults' behavioral beliefs and their intentions to take their medications regularly as prescribed.

2.6 Study Relationships and Conceptual Model

The study model (Figure 2.1) combines the Behavioral Beliefs and Intentions constructs of the Theory of Planned Behavior to examine the effect of framing on Adherence to ICS and Asthma control. This study proposed that framed messages will differentially affect young adults' Beliefs about medications, Intentions to take medications, Medication Adherence, and Asthma Control. Specifically, gain framed messages were expected to be more effective in improving young adults' Beliefs about medications, Intentions to take medications, Medication Adherence, and Asthma control. This proposal was based on the suggestion by Rothman and colleagues that gain-frame should be more effective in persuading individuals to perform a preventive behavior.[82] The suggestion was supported by the findings of a recent systematic review and meta-analysis of health message framing.[16] Additionally, this dissertation proposed that young adults' Beliefs (outcome expectancy) would mediate framing effects on Intentions.

Figure 2.1 Conceptual Model of Study
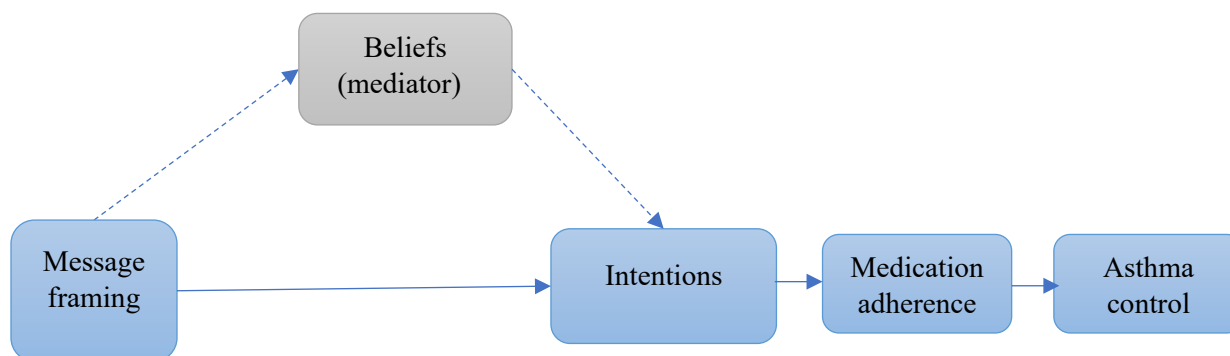
2.7 Summary of the Literature Review

There are limited health promotion studies specifically targeting young adults. Although this review identified a few studies promoting medication adherence among young adults, the populations were limited to African-Americans.[15,169] Well-designed interventions specifically targeting young adults of all races are highly recommended to provide evidence-based solutions for this age group. An mHealth intervention is a viable option for this age group given the prevalence of cellphones among this demographic. Existing studies have also reported on the acceptability and helpfulness of mHealth interventions to young adults.[23,169]

Furthermore, young adults with asthma have indicated a preference for text message interventions to promote adherence to inhaled corticosteroids.[23] Message framing, a psychological construct that capitalizes on an individual's risk perceptions to influence his or her decision-making, by either emphasizing losses or gains in message presentation, may help with text message development. Message framing has been used to promote the adoption of various healthful behaviors including vaccinations, smoking cessation, use of sunscreens, mammography or breast self-examination, and other types of health screening.

Promoting decisions to take medications as prescribed via message framing is of utmost importance given that intentional nonadherence – an active decision to alter or miss a dose – is prevalent among individuals with asthma.[126] Studies have also reported that young adults have peculiar challenges owing to their developmental stage.[13,14,20] Indeed, young adulthood is an age of possibility; a time when optimism is universal. This makes young adults very susceptible to optimistic bias which may lead them to underestimate the consequences of not taking their medications as prescribed.

Self-focus, another feature of the young adulthood developmental stage, connotes independence and freedom from social structures that oversee young adults.[20] This includes parental oversight. First, a lack of parental supervision implies that young adults have to remember to take medications by themselves. Second, young adults no longer report to their parents. They feel that they can independently make decisions about what is good for them.[13] This includes making medication-taking decisions irrespective of what the prescribed regimen.[13] Framing of messages may help support the decision-making of young adults, prompting them to adopt regular medication-taking as prescribed. Additionally, intentional nonadherence stems from concerns about potential adverse events, disbelief that asthma is chronic, and disbelief that the medications are effective.[126,135] Framed messages may therefore, change young adults' beliefs about their medications, their intentions to take medications as prescribed, adherence to ICS, and asthma outcomes.

Additionally, variables from existing theories of behavior change may further help to provide a theoretically based explanation of the effects of message framing. Specifically, outcome expectancy may mediate the effects of framing on young adults' intentions to take medications as prescribed. Outcome expectancy is a construct of Social Cognitive Theory and the Theory of Planned Behavior (operationalized as behavioral beliefs here). Intentions is a core construct of the Theory of Planned Behavior as well. Intentions to perform a behavior can lead to an actual performance of the behavior.[55]

CHAPTER 3: METHODS

3.1   Research Overview

The first research question that this dissertation study addresses is, "What are the relevant asthma outcomes experienced by young adults?" This question is addressed by Aim 1 of this study, using a systematic review. The second research question is, "What are the effects of framed messages on the behavioral beliefs of young adults, their intentions to take medications, their medication adherence, and asthma control?". This question is addressed by aim 2 using a text messaging intervention. The third research question is, "What is the relationship between message frame, beliefs, intentions, adherence, and asthma control?". This question is addressed in aim 3 using a path analysis.

Using constructs of the Theory of Planned Behavior as the conceptual framework, the primary objective of this study is to examine the effects of message framing (a construct based on Prospect Theory) on young adults' beliefs about medications, intentions to take medication, medication adherence, and asthma control. This study posits that message framing will influence young adults' beliefs about medications, intentions to take medications, medication adherence, and asthma control. In addition, this study posits that the effects of framing on beliefs and intentions will differ based on the participants' intrinsic type of nonadherence (intentional vs unintentional). Additionally, based on the logical mechanism of framing, this study posits that beliefs will mediate the effects of message framing on intentions to take medications. This chapter describes the methods used to study these anticipated relationships.

3.2   Research Aims and Hypotheses

The primary objective of this study is to examine the effects of message framing on young adults' behavioral beliefs about medications, intentions to take medication, medication adherence, and asthma control. Figure 3.1 shows the logic model of the study.

Figure 3.1 Logic Model of Study

Framed Messages	Short term Outcomes	Intermediate Outcome	Health Outcome
Gain and loss framed text messages	More positive beliefs	Improved Medication adherence	Improved Asthma control
	Increased intentions		
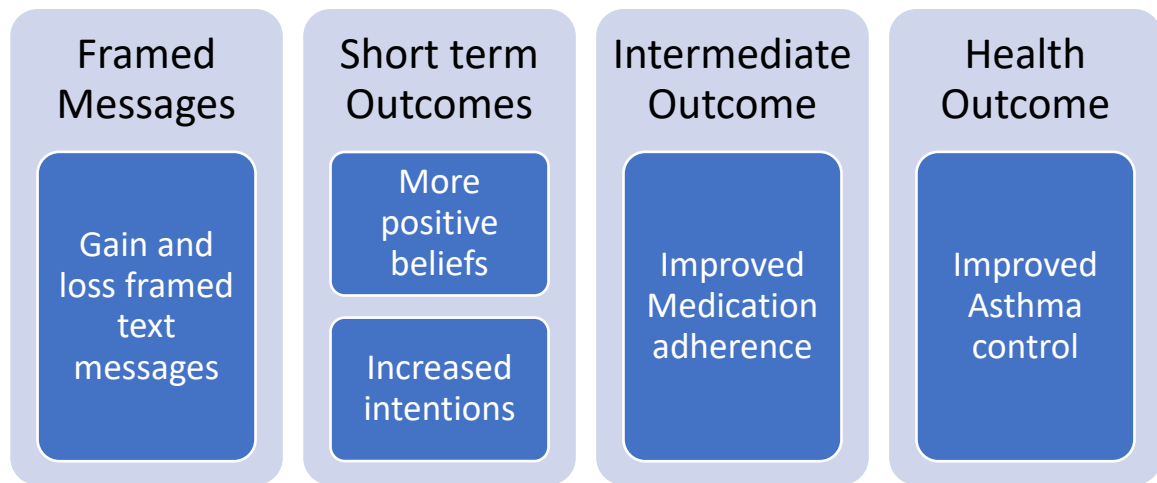
To provide a theoretical explanation of the effects of message framing, constructs from the Theory of Planned Behavior were used in constructing a conceptual model (Figure 2.1). The specific aims and hypotheses (alternate hypotheses) of this study are:

Aim 1: To develop gain- and loss-framed messages for promoting medication adherence among young adults with asthma.

Sub aim 1.1 – To identify asthma outcomes concepts from which to construct messages

Sub aim 1.2 – To develop gain- and loss-framed messages to promote medication adherence

Aim 2: To examine the effects of gain- and loss-framed messages on Beliefs, Intentions to take medications, Medication Adherence, and Asthma Control.

Hypothesis 1a: Participants receiving gain-framed messages will have more positive beliefs about their medications compared to those receiving loss-framed messages as determined by the BMQ-specific scale administered at baseline and week eight.

Hypothesis 1b: Participants receiving gain-framed messages will have greater intentions to take their medications as prescribed compared to those receiving loss-framed messages as determined by an intentions scale administered at baseline and week eight.

Hypothesis 1c: Participants receiving gain-framed messages will have greater adherence to their medications compared to those receiving loss-framed messages as determined by the MARS-A scale administered at baseline, week 4, and week 8.

Hypothesis 1d: Participants receiving gain-framed messages will have greater asthma control compared to those receiving loss-framed messages as determined by the ACT administered at baseline, week four, and week eight.

Hypothesis 2a: There will be a significant increase in positive beliefs at the end of study compared to baseline among participants receiving both gain-and loss-framed messages as determined by the BMQ-specific scale administered at baseline and week eight.

Hypothesis 2b: There will be a significant increase in intentions at the end of the study compared to baseline among participants receiving both gain- and loss-framed messages as determined by an intentions scale administered at baseline and week eight.

Hypothesis 2c: There will be a significant increase in adherence at the end of the study compared to baseline among participants receiving both gain- and loss-framed messages as determined by MARS-A administered at baseline, week four, and week eight.

Hypothesis 2d: There will be a significant increase in asthma control from baseline among participants receiving both gain- and loss-framed messages as determined by the ACT administered at baseline, week four, and week eight.

Aim 3: To examine the relationship between Message Frame, Beliefs, Intentions, Medication Adherence, and Asthma Control

Hypothesis 3: Framing will have a direct positive relationship with Beliefs and Intentions.

Hypothesis 4a: Beliefs will mediate the effects of framing on Intentions.

Hypothesis 4b: Beliefs will have a direct positive relationship with Intentions.

Hypothesis 5: Intentions will mediate the effects of Beliefs on Medication Adherence.

Hypothesis 6: Medication Adherence will have a direct positive relationship with Asthma Control.

3.3 Approach by Aim

3.3.1   Aim 1: To develop gain- and loss-framed messages for promoting medication adherence among young adults with asthma.

Rationale: Message framing is expected to promote positive decision-making regarding taking regular ICS as prescribed. The type of framing utilized in this study is goal-framing, which involves framing an advocated behavior with an emphasis on its potential to prevent or avoid a negative outcome (loss-frame), or on its potential to provide a benefit or positive outcome (gain-

frame). To ensure that the messages are relevant to young adults, a qualitative meta-synthesis of studies reporting on the impact of asthma on young adults was undertaken. Qualitative meta-synthesis is the systematic review and integration of findings from qualitative studies.[170] It provides answers to scientific questions by emphasizing the participants' subjective experience.[170] A qualitative meta-synthesis was chosen because of its ability to provide in-depth information on how asthma impacts young adults from their perspective. Concepts from this qualitative review were then used in developing a bank of gain- and loss-framed messages.

3.3.1.1 Sub-Aim 1.1: Qualitative Meta-synthesis

To identify the asthma outcome concepts from which to construct messages in aim 1, a qualitative meta-synthesis was conducted. The focused question was, "What is the experience of living with asthma as a young adult?".

3.3.1.2 Eligibility Criteria

Types of Studies: This study included qualitative studies and mixed method studies with a qualitative section published in peer reviewed journals describing patient reported outcomes associated with asthma. Qualitative studies were included because of their ability to provide in-depth information of outcomes from the patients' perspective.

Types of Participants: Studies describing the experience and views of young adults between the ages of 18 and 29 living with asthma were eligible for inclusion.

Outcomes: Studies describing the outcomes or impact of asthma on young adults from the patients' perspective were eligible for inclusion.

Exclusion Criteria: Studies that describe asthma outcomes from sources other than patients, quantitative studies, systematic reviews, study protocols, studies where patients have comorbid conditions such as Chronic Obstructive Pulmonary Disease, or non-English language studies were excluded.

Literature Searches, Study Identification, and Selection: Three databases including PubMed, CINAHL, and PsycINFO were searched from the creation of each database till March 2019. Additional articles were identified through a high sensitivity search of Google Scholar through March 2019. The search strategy that was used is outlined in Appendix 1.

Two independent reviewers applied the search criteria to the different databases, transferred the searches to a citation manager, and then independently managed the citations following the Preferred Reporting Items for Systematic Review and Meta-Analysis guidelines (PRISMA).[171] Disagreements on the studies to include were discussed and resolved between the two reviewers.

Data Extraction and Management: All included studies were uploaded to ATLAS.ti version 8 (ATLAS.ti Scientific Software Development GmbH, Berlin, Germany) for analysis and synthesis.

Quality Assessment: The methodological quality and risk of bias of included studies were assessed using the Mixed Methods Appraisal Tool (MMAT).[172] The MMAT tool is an appraisal tool for evaluating the quality of qualitative, quantitative, and mixed-method studies. Interrater reliability of quality assessment scores was analyzed in the form of percent agreement.

Data Analysis and Synthesis: Coding of each study's findings was conducted to reflect the experience of living with asthma as a young adult. The primary investigator coded the entire data

inductively, developed a code book, and discussed the code book with the second investigator. The second author then coded 20% of the data using the code book. Krippendorf's alpha was calculated as a measure of inter-coder reliability. Themes were discussed and modified by the two authors until consensus was reached. A grounded theory approach was used in generating categories of concepts associated with living with asthma as a young adult.[173] Grounded theory is a systematic method used by researchers to identify concepts and build theory from qualitative data.[173] Preliminary categories were repeatedly compared to data and the codes throughout the analysis using the constant comparison technique.[174]Apart from the iterative process of comparing data with codes, codes with codes, and categories with codes, analysis also included reflecting on the primary author's notes maintained throughout the process as well as theorizing on what it means to live with asthma as a young adult by studying the emerging ideas.

Preliminary Findings: Initial database searches were performed during December 2018 using the search strategy outlined in Appendix 1. The searches yielded the following number of studies – PubMed (199), CINAHL (247), and PsycINFO (170). A random search in one of the databases (PubMed) indicated that at least 4 articles were eligible for inclusion in the study. Although the literature suggests that there is no minimum amount of studies for a qualitative meta-synthesis, typically, final studies eligible for inclusion in the review is within the range of 2 to 3% of initial number of searches results, which is about 12 studies in this case.[170]

Potential Limitations: A potential limitation is the non-generalizability of findings to a population different from young adults. However, the intention of this study is to interpret the outcome of synthesizing first order themes (themes from participants) into a new theory about living with asthma as a young adult. Another limitation is the potential inability to generalize

findings to all young adults due to a low representation of a subgroup of participants. An example includes racial minorities due to low publication.

3.3.1.2 Sub-Aim 1.2: Message Development

A library of gain- and loss-framed text messages were developed using findings from a qualitative meta-synthesis on the experience of living with asthma as a young adult.

Experimental Approach: Codes from the systematic review were used in drafting gain- and loss-framed messages (Table 3.1). These messages were presented to a psychologist specializing in decision-making and message framing for face validity assessment and feedback on the tone, clarity, and persuasiveness of the messages. The messages were refined accordingly and also presented to an individual with asthma for feedback on the relevance for an audience with asthma. The length of messages was restricted to 160 characters, the standard length of one SMS page. A total of 52 messages consisting of 26 gain-framed messages about the positive consequences of adherence and 26 loss-framed messages about the negative consequences of nonadherence were developed (Table 4.3). A total of 26 messages per frame made it possible to send three messages per week for four weeks from the message library, which is consistent with the preference of young adults. Young adults prefer to receive text messages on weekdays and are comfortable with receiving the messages daily.[15,165]

Table 3.1 Sample Code and Message

#	Code	Gain-framed message	Loss-framed message
1	Feeling uncomfortable	Taking your daily inhaled medications DECREASES	Skipping your daily inhaled medications INCREASES your

		your chance to be uncomfortable because of asthma.	chance to be uncomfortable because of asthma.

Limitations: Apart from the perspective of young adults informing message construction, young adults' opinion on the final drafts were not elicited. This would have been useful in providing information on the acceptability of the messages by this demographic. However, the opinion of the target audience is not typically obtained in framing research.[46,83] This study has an added advantage of systematically identifying outcomes relevant to the target audience; a process which has not been performed in previous framing studies. Another possible limitation is having only three text messages per week. It may have been helpful to have more text messages per week to increase the dose of the intervention. However, a limited number of text messages were created due to plans to utilize three text messages per week to fit with budgetary plans and findings from previous literature regarding preferences among young adults.

3.3.2

Aim 2: To examine the effects of gain- and loss-framed messages on Beliefs, Intentions to take medications, Medication Adherence, and Asthma Control.

Aim 3: To examine associations between Message Frame, Beliefs, Intentions, Medication Adherence, and Asthma Control.

3.3.2.1 Rationale

Rationale: Aims 2 and 3 utilized the same sample and methods, therefore, they are described together. Aim 2 sought to determine whether asthma-related Medication Beliefs, Intentions,

Medication Adherence, and Asthma Control differed between a group receiving gain-framed messages and one receiving loss-framed messages. It also sought to determine whether participants' Beliefs, Intentions, Medication Adherence and Asthma Control at the end of the study differed from baseline among all participants. A mixed design Analysis of Variance (ANOVA) was chosen for assessment. Aim 3 seeks to examine the relationship between Message Frame, Beliefs, Intentions, Medication Adherence, and Asthma Control. We expected to see hypothesized relationships as earlier described in the study's conceptual model. Path analysis was used to test the hypothesized relationships.

3.3.2.3 Research Design / Experimental Approach

A parallel arm randomized trial was utilized to accomplish aims 2 and 3. Participants were randomly assigned to two groups by a computer program: gain-frame (group 1) and loss-frame (group 2).

3.3.2.4 Participants and Settings

<u>Inclusion and Exclusion Criteria:</u> College students between the ages of 18 to 29 years old who can read and write English, have been diagnosed with asthma, and indicated possession of a prescription for an inhaled corticosteroid were eligible to participate. The age bracket of 18 to 29 was used because this is the age bracket of young adults.[175] Participants had to be enrolled at Auburn University during the semester of data collection, possess a smartphone, and be willing to provide their phone numbers to receive text messages during the study.

<u>Recruitment:</u> All participants were recruited from Auburn University. An email was sent to potential participants (n = 19,636) inviting them to participate in the study via University

personnel authorized to send similar emails to students. Fliers advertising the study were also

posted in the school library and departmental offices across campus. Both email and fliers

contained a description of the study, a request for participation, and included the contact

information of the primary investigator (email address and phone number). Individuals interested

in participating contacted the primary investigator by telephone call. During the phone call

(script available in Appendix 3), questions were asked to assess the eligibility of the caller to

participate in the study. If eligible, more information about the study was provided, and the caller

was also given an opportunity to decide whether they wanted to participate. All participants who

contacted the primary investigator, met the eligibility criteria for the study and indicated a desire

to participate were enrolled for the study. Prior to participation, the study was explained to the

participants, and they were required to read and sign an informed consent form approved by the

Institutional Review Board (IRB) of Auburn University.

Participants were incentivized with Amazon gift cards to encourage enrollment and

prevent attrition. Specifically, $10 was provided at baseline after completion of the baseline

survey. A drawing for a chance to receive a $10 Amazon gift card was performed at the end of

week four, with the chance of being drawn equivalent to one out of ten., Finally, a $15 Amazon

gift card was provided upon completion of study at the end of week eight.

Sample Size – To detect an asthma control effect size of 0.25 at a significance level of 5% and a

power of 80%, a total of 86 participants was required. A conservative effect size of 25% was chosen

because existing studies do not provide effect size estimates. Sample size calculations were performed

using the G*power statistical power analysis program.[176] For path analysis used in aim 3, it was

estimated that a sample size of at least 50 will be adequate based on the conventional rule of

having at least 10 participants per estimated parameter (Message Frame, Belief, Intentions,

Medication Adherence, and Asthma Control)[177] We intended to use the larger sample size of 86 inflated to 96 to allow for attrition.

3.3.2.5 Intervention

The intervention consists of loss- and gain-framed text messages previously developed in aim 1. The loss- and gain-framed messages were sent to participants randomized to group 1 and 2, respectively, via text messages. Texting frequency was informed by the literature which suggests that young adults prefer to not to see repeat text messages, or receive text messages too early in the morning, late at night or during weekends.[165,178] Young adults prefer to receive messages between 10am and 7pm, and either twice daily or daily messages are acceptable to young adults.[164] Since daily and twice daily messages are not considered cumbersome, three times per week was deemed reasonable for this sample.[13,15] Three times per week was chosen due to budgetary feasibility. Text messages where only delivered on week days as weekends are not desirable by young adults.[165]

Text messages were sent three times per week between 10am and 7pm via a third-party texting platform, EZ texting.[179] Specifically, participants were texted on Mondays, Wednesdays, and Fridays. EZ texting, provides a platform for sending text messages for multiple people and charges 5 cents per message. The texting was performed by the primary investigator, who also kept track of the messages that have been sent. Participants were requested to acknowledge receipt of message by replying with an "R". Although the text message library contained a total of 52 messages, only 48 messages were used for the intervention. The remaining two pairs (gain- and loss-framed messages) of messages were not sent because only 48 were needed. Texting began in August and ended in October, on a rolling basis as participants were recruited (Figure 3.2).

Figure 3.2. Sequence of Steps in the Research Design

| Participants randomized into gain or loss frame | Baseline - Week 0 Measures collected: Demongraphics, Beliefs, Intentions, Medication adherence, Asthma control — Text messaging began | Week 4 Measures collected: Asthma control, Medication adherence | Week 8 Mearsures collected: Beliefs, Intentions, Medication adherence, Asthma control, Type of nonadherence — Text messaging ended |

3.3.2.6 Measures and Data Collection

<u>Demographic Information:</u> During the baseline survey administered via qualtrics, participants' demographic information including gender, age, ethnicity, and race were elicited.

<u>Beliefs:</u> The Beliefs about Medications Questionnaire (BMQ)-Specific (Appendix 4),[180] was used in measuring Beliefs (behavioral beliefs). BMQ-specific consists of two scales consisting of five items each. The first scale assesses beliefs about the *necessity* of prescribed medications while the second scale assesses *concerns* about prescribed medications based on beliefs about the danger of dependence, long term side effects, and disruptive effect of medications. The BMQ-specific scale elicits participants' agreement with salient medication beliefs from completely disagree (1) to completely agree (5). Example concern statements from the BMQ-specific include, "having to take medicines worries me" and, "I sometimes worry about becoming too dependent on my medicines". Example necessity items include, "My health at present, depends on my medicines" and, "Without my medicines, I will be very ill". Beliefs are calculated as the

difference between necessity and concerns scores, with a possible range of - 20 to 20.[138] Beliefs were measured at baseline and at the end of week eight.

Intentions: The sum of participants' response to three items:[181] "I intend to take my inhaled asthma medications as prescribed"; "I will take my daily inhaled asthma medication as prescribed"; and "I will always take my inhaled asthma medications as prescribed", was used to measure Intentions. These items were scored on a five-point Likert type scale from strongly disagree (1) to strongly agree (5). Intentions were measured at baseline and at the end of week eight.

Medication Adherence: The Medication Adherence Report Scale for Asthma (MARS-A) (Appendix 6),[31] was used to elicit participants' adherence to their controller medications (ICS or ICS combinations) at baseline, week four, and week eight. The following statement precedes MARS-A items: '*Many people find a way of using their medicines which suits them. This may differ from the instructions on the label or from what their doctor had said. Here are some ways in which people have said they use their medicines. For each statement, please tick the box which best applies to you*'. An example of a MARS-A item is, "I try to avoid using it".

This scale has been shown to be valid and reliable.[31] Each item is rated on a five-point Likert-type scale with higher scores indicating greater adherence. Adherence was measured as a continuous scale as recommended by literature, rather than as a dichotomous division into adherent/nonadherent categories.[182] A previous study has also used the MARS-A instrument in a similar manner.[138] This scale has demonstrated good test-retest reliability ($r = 0.65$, $p < 0.001$) and correlates well with electronic adherence ($r = 0.42$, $p < 0.001$).[31]

Type of Nonadherence: Two items from MARS–A were used in measuring type of nonadherence as reported by a previous study.[123,135] Specifically, Individuals who indicated agree or strongly agree to either of the following sentences would be categorized as intentionally nonadherent: "I alter the dose", "I decide to miss out a dose".

Asthma Control: The ACT questionnaire (Appendix 5), a valid and reliable self-report[33] was used in measuring participants' asthma control at baseline, week four, and week eight. The ACT consists of five items, which are rated by the individual whose asthma control is to be measured. It measures asthma control by asking questions pertaining to asthma symptoms that occurred in the past four weeks. Response set ranges from All of the time (1) to None of the time (5). The total scores for the ACT ranges from 5 to 25, with individuals scoring 19 and less considered uncontrolled.[32] An example ACT item is, "In the past four weeks, how much of the time did your asthma keep you from getting as much done at work, school, or at home?" The ACT has demonstrated high internal consistency (Cronbach's' $\alpha = 0.85$) and significant correlations with specialists' rating of asthma control ($r = 0.52$, $p < 0.001$).[33] A Minimally Important Difference (MID) of 3 reflects the smallest difference in score with a clinically significant change.

Marlowe Crown Scale: Social desirability is the need of individuals to obtain approval by responding in a culturally appropriate manner.[183] Since self-report is susceptible to social desirability bias, the short form of the Marlowe Crown Scale (Appendix 7) was administered to identify individuals who are likely to respond in a socially desirable manner.[184] This scale has 10 statements to which individuals may respond with either true of false. Scores range from 0 to 10 (no social desirability to high social desirability).[184] Example of items in this scale include: "I always try to practice what I preach", "I'm always willing to admit it when I make a mistake",

and "I have never deliberately said something that hurts someone's feelings". Social desirability was measured at baseline only.

3.3.2.7 Statistical Analysis

Descriptive statistics of participants' baseline characteristics including age, sex, grade level, race, ethnicity, medication adherence, and ACT score were computed. A bivariate analysis comparing the main variables (beliefs, intentions, medication adherence, and asthma control) with social desirability scores was performed to determine if social desirability was a confounder. All statistical analyses were performed using SPSS version 23.[185] The statistical analyses for each aim are as follows:

Aim 1: Krippendorf's alpha depicting inter-coder agreement for the qualitative meta-synthesis was calculated.

Aim 2: Descriptive statistics were performed for all variables. The average Beliefs and Intention scores measured at baseline and week eight were compared across groups using the two-way mixed ANOVA. The within factor is time (baseline and week eight) while the between factor is the group (loss- versus gain-frame). The average MARS-A and ACT score were compared across groups at baseline, week four, and week eight, respectively, using the two-way mixed ANOVA. The within factor is time (baseline, week four, and week eight) while the between factor is the group (loss-frame versus gain-frame). Changes of all parameters from baseline, irrespective of group, was also assessed. We also compared the proportion of individuals achieving a MID of 3 at month one and month two using the Chi-square test.

Aim 3: A bivariate correlation analysis was performed to provide an overview of relationships between variables. Path analysis was also performed to assess hypothesized relationships.

The summary of the studies data analyses plan is indicated in Table 3.2 below.

Table 3.2 Summary of Data Analyses Methods

Aim	Outcome	Variables	Instrument	Timepoint	Analysis
1.1	Themes of outcomes related to adherence to ICS	-	-	-	Coding and grounded theory analysis
2	Change in mean score of Belief in group 1 vs. group 2	IV: Group 1 vs. 2 DV: Beliefs	BMQ, Intentions scale	Baseline, week eight	Descriptive statistics, Two-way mixed ANOVA
	Change in mean score of Intentions in group 1 vs. group 2	IV: Group 1 vs. 2 DV: Intentions	Intentions scale	Baseline, week eight	Descriptive statistics, Scores are summed to create a total scale score, Cronbach's alpha for internal consistency, Exploratory factor analysis for construct validity, Two-way mixed ANOVA
	Change in mean Medication Adherence in group 1 vs. group 2	IV: Group 1 vs. 2 DV: Medication adherence	MARS-A	Baseline, week four, week eight	Descriptive statistics, Two-way mixed ANOVA • Within factor (time) • Between factor (message frame)
	Change in mean ACT score in group 1 vs. group 2	IV: Group 1 vs. 2 DV: Asthma control	ACT	Baseline, week four, week eight	Descriptive statistics, Two-way mixed ANOVA, Chi square test
3	Relationship between Framing, Beliefs, Intentions, Medication Adherence, and Asthma control	IV: Message frame DV: Beliefs, Intentions, Medication Adherence,	BMQ, Intentions scale, MARS-A, ACT	Week eight, Baseline	Bivariate analysis, Path analysis

		Asthma control			

3.3.2.8. Plan for Dealing with Missing Data

We planned to use an intent-to-treat approach for data analyses. To achieve this, we planned to include respondents in analyses across different timepoints even if their data was missing. However, since participants in this study contributed data across all time points, we didn't have any missing data. At the survey development level, we enforced a forced-response function on items in the questionnaire to ensure that participants provided response to every item, eliminating item non-response.

3.3.2.9 Expected Findings

- Aim 1: We expected to have an emerging theory on the phenomenon "living with asthma as a young adult".

- Aim 2: The effects of gain- and loss-framed messages on young adults' beliefs about medications, their intentions to take medications as prescribed, adherence to medication, and asthma control will be uncovered.

- Aim 3: Additionally, the study will reveal the relationship between message framing, beliefs, intentions, medication adherence, and asthma control.

3.3.3 Potential Limitations

There are several potential limitations. First, the study relies on self-report which makes it susceptible to social desirability bias. However, participants tendency to respond in a socially

desirable manner was assessed using the Marlowe-Crowne's social desirability scale. Second, the study is also susceptible to recall bias because of the use of self-report measures. Third, the study focuses on young adults who are enrolled in college. Findings may not generalize to all young adults. It was not possible to know if participants in the study knew each other creating a possibility of contamination with participants being exposed to framed messages that differed from what they were supposed to be exposed to. Finally, insufficient publications about living with asthma as an emerging adult may lead to some demographics not being captured in the qualitative meta-synthesis.

Ethical Approval: Prior to conducting the study, an approval was received from Auburn University's Institutional Review Board. All participants provided an informed consent to participate in the study.

CHAPTER 4: RESULTS

Results for aim 1 include two parts. The first part describes findings from the systematic review and meta-synthesis of the experience of young adults living with asthma. The second part describes the gain- and loss-framed messages developed from the findings of part one. Results for Aim 2 include the effect of a two-month framing intervention on participants' beliefs about medication, intentions to take medication, adherence, and asthma control. This is followed by results from the third aim, which uses path analysis to examine hypothesized relationships between Message Frame, Beliefs, Intentions, Medication Adherence, and Asthma Control.

4.1 Aim 1: Systematic Review and Qualitative Meta-Synthesis

The literature searches yielded 472 records after duplicates were removed. Of those, 30 full text articles were assessed for eligibility, and six articles were included in the study. We also searched the references of all included studies to identify any additionally relevant studies. One additional study was identified and included. The PRISMA diagram showing the study selection process is depicted in Figure 4.1. Two studies utilized a mixed method design while the remaining five utilized a qualitative design. Three studies were conducted in Australia, one in the United Kingdom, two in the United States, and one in Denmark. Two studies explored the experiences of young adults living with asthma to inform the development of a self-management app,[186,187] one explored the same topic to inform the development of an educational video,[188] the remaining four did not inform the development of technology.[13,22,23,189] A study focused on the experiences of young adults to uncover reasons for overuse of rescue medications.[22] One study focused on young Muslim women,[189] while two others focused on African-American young adults.[13,23] A summary of the characteristics of included study are described in Table 4.1. Agreement between the two independent researchers assessing the quality of included studies was 57 percent. A final quality assessment result was arrived by consensus (Appendix 2). The

quality of three included studies were rated as 75% while four studies were rated a 100% (Appendix 2). A total of 113 codes were generated with five emerging categories. Agreement between the two independent coders of included studies was 0.71 (Krippendorf's Alpha).

Figure 4.1 Study Identification and Selection following the PRISMA Guidelines

617 records identified through database searches

4 records identified through Google Scholar searches,
1 record through other sources

472 records after removal of duplicates

472 records screened

441 records removed after screening

31 full text articles assessed for eligibility

24 records excluded

- Not young adults (17)
- Review article (1)
- Providers' perspective (1)
- Included COPD patients (1)
- Not qualitative or mixed method study (4)

7 studies included

Table 4.1 Characteristics of Included Studies

Author (year)	Sample size	Sampling Technique	Study Design	Methods	Aims
[22]Cole S, et al. (2013)	21	Purposive	Qualitative	Semi-structured interviews	To determine the reasons for overuse of rescue medications among young adults living with asthma
[188]Coombs N, et al. 2018	20	Convenience	Mixed Method	Web-based and face to face in-depth interviews	To explore the health literacy, asthma experience, and help-seeking behaviors of young university students to inform the development of a web-based asthma education intervention
[186]Davis SR, et al. 2018	20	Random sampling	Mixed method	Literature review, survey, audio recorded workshops, and participant completed worksheets	To utilize a patient-driven participatory approach to develop an engaging asthma app
[189]Druedahl LC, et al. 2018	10	Convenience sampling	Qualitative	Interviews and focus groups	To explore the role of self-efficacy in adherence to asthma medicine treatment and the influence of religion on self-efficacy among young, Muslim minority women

[13]MacDonell KK, et al. 2015	19	Purposive	Qualitative	Semi-structured interviews	To explore barriers to adherence in the context of the transition into adulthood
[23]Speck LA, et al. 2014	34	Purposive	Qualitative	Focus groups	To understand the experiences and perspectives of young African American adults managing their asthma.
[187]Peters D, et al. 2017	20	Convenience	Qualitative	Qualitative analysis of participant generated artifacts (e.g. collages, concept maps, and paper prototypes) and audio recordings	To explore the experience, needs, and ideas of young people with asthma while allowing them to define requirements for an asthma app that would be engaging and effective at improving their well-being.

4.1.1 Living with Asthma as a Young Adult

Five categories related to the phenomenon of "living with asthma as a young adult" emerged (Figure 4.2). The codes and concepts of each emerging category are outlined in Table 4.2. We found that young adults have several *needs*, *barriers*, and *enablers* to support disease management. They also exhibit several *behaviors* which lead to different *outcomes* pertaining to living with asthma.

Figure 4.2. Theoretical Model of Living with Asthma as a Young Adult

Table 4.2 Codes and Concepts of Emerging Categories

#	Category: Needs	Concept
1	Describing how asthma medications work	Asthma management
2	Expressing a preference for rescue medications	Asthma management
3	Explaining how asthma works	Education

4	Expressing need for public education about asthma	Education
5	Facing difficulty in explaining what it means to live with asthma	Education
6	Lacking ways to explain the discomfort of asthma to others	Education
7	Preferring certain approaches of learning about asthma	Education
8	Expressing needs on information about the weather and pollen	Information
9	Gathering information about asthma	Information
10	Getting information from family members	Information
11	Recounting doctor's instruction on inhaler use	Information
12	Seeking knowledge of condition from parents	Information
13	Recounting mother's support in taking medication	Social support
14	Relying on parents for assistance in managing asthma	Social support
15	Running out of medication due to lack of insurance	Social support
16	Seeking help from health professionals	Social support
17	Seeking support from parents	Social support
#	**Category: Barriers**	**Concepts**
1	Seeing self as strong willed	Autonomy over asthma

2	Thinking they have control over asthma	Autonomy over asthma
3	Failing to fill medication due to cost	Cost
4	Hating to pay for asthma medications	Cost
5	Having lapses in insurance	Cost
6	Lacking medication coverage by insurance	Cost
7	Running out of medication due to lack of insurance	Cost
8	Feeling overwhelmed with daily medication use	Decreased support
9	Missing parental support	Decreased support
10	Dissatisfaction with amount of time spent with physician	Dissatisfaction with care
11	Expressing dissatisfaction with a lack of shared decision making	Dissatisfaction with care
12	Forgetting to take medications	Forgetfulness
13	Acknowledging irresponsibility in medication taking	Irresponsibility
14	Failing to take preventer medication as prescribed	Irresponsibility
15	Admitting a lack of knowledge on how the medication works	Knowledge
16	Admitting to discrepancy between knowledge of asthma care and actual asthma care	Knowledge

17	Admitting uncertainty on what the medication does	Knowledge
18	Grappling with understanding disease	Knowledge
19	Wishing asthma has a cure	Knowledge
20	Deciding not to learn more about asthma	Negative decisions
21	Deciding not to take medications	Negative decisions
22	Admitting a lack perceived benefit for preventer medications	Negative perception
23	Admitting lack of observed benefits of preventer medication	Negative perception
24	Perceiving rescue medications to be more useful than preventive medications	Negative perception
25	Having negative perceptions of medications	Negative perceptions
26	Caring what people think	Perception of others
27	Hating to carry a spacer around	Perception of others
28	Hating to carry medications around	Perception of others
#	**Category: Enablers**	**Concept**
1	Being aware of asthma triggers	Awareness of triggers
2	Making effort to learn how to manage asthma	Being responsible
3	Using alarms to remember to use medications	Cues
4	Acknowledging that failure to take preventer leads to worsening symptoms	Knowledge
5	Admitting the chronic nature of asthma	Knowledge

6	Admitting the effectiveness of controller medication	Knowledge
7	Admitting to an immediate benefit of reliever medications	Knowledge
8	Feeling the effect of medication	Knowledge
9	Knowing what to do	Knowledge
9	Knowing when to use medication	Knowledge
10	Fighting for good outcomes for the sake of future	Motivation
11	Listening to parents' opinion on asthma care	Social support
#	**Category: Behavior**	**Concept**
1	Being rebellious about taking medications	Negative
2	Buying only rescue inhalers when short of cash	Negative
3	Doubling up on medication	Negative
4	Exercising control over asthma	Negative
5	Stopping medications when better	Negative
6	Taking medications only when ill	Negative
7	Admitting to not taking medication	Negative
8	Admitting to using only rescue medication	Negative
9	Calling in for refills	Positive
10	Coughing serves as cue to take medications	Positive
11	Enforcing an adherence strategy	Positive

12	Making reliever medications available	Positive
13	Taking care of self	Positive
14	Taking rescue medication to feel comfortable	Positive
15	Taking reliever medications right away	Positive
16	Taking rescue medication when preventer is not doing enough	Positive
17	Using medications	Positive
18	Using preventer medication daily and rescue medication as needed	Positive
#	**Category: Outcomes**	**Concept**
1	Experiencing a flare-up	Disease specific
2	Experiencing side effects of medication	Disease specific
3	Feeling breathless during workout	Disease specific
4	Feeling chest tightness	Disease specific
5	Feeling chest tightness while dancing	Disease specific
6	Feeling shortness of breath	Disease specific
7	Feeling the effect of medication	Disease specific
8	Getting asthma symptoms due to the stress of exams	Disease specific
9	Having a severe cough and breathing difficulties	Disease specific
10	Having an exacerbation due to stress	Disease specific
11	Hyperventilating	Disease specific

12	Being unable to play with child	Interpersonal
13	Experiencing stigma from people	Interpersonal
14	Facing a family separation due to asthma	Interpersonal
15	Facing exclusion from events	Interpersonal
16	Feeling judged because of asthma	Interpersonal
17	Stopping in the middle of sex because of asthma	Interpersonal
18	Being unable to perform household chores	Personal
19	Being unable to train like an athlete	Personal
20	Changing jobs due to asthma	Personal
21	Changing life because of asthma	Personal
22	Expressing a lack of resentment with having asthma	Personal
23	Facing inability to wear tight clothes due to asthma	Personal
24	Feeling anger at having asthma	Personal
25	Feeling anger due to stigma	Personal
26	Feeling confident	Personal
27	Feeling different	Personal
28	Feeling fear during a flare up	Personal
29	Feeling fear in joining preferred career	Personal
30	Feeling free of asthma	Personal
31	Feeling restricted from farming	Personal

32	Feeling sicker than others	Personal
33	Feeling uncomfortable	Personal
34	Feeling unsafe	Personal
35	Freaking out because of an exacerbation	Personal
36	Giving up running because of asthma	Personal
37	Slowing down at work because of asthma	Personal

Needs: We categorized concepts that referred to a requirement or necessity as needs. Young adults expressed needs for information on weather, pollen, asthma, and asthma management.[23,186-188] They also have preferences on how information should be presented.[188] Some people gather information from family members (especially parents) and healthcare providers.[188] In terms of asthma management, specific needs reported by some people included information on how asthma medications work and how to use inhaler devices.[188] Some young adults would like information on the disease itself with preferences on how information should be presented.[186,188] Other needs include social support from parents, parental support with disease management, support from healthcare providers, public education about asthma so that others can understand how to help in cases of acute illness, and autonomy over asthma.[188]

Barriers: We categorized concepts that described a difficulty or potential barrier to asthma management as barrier. Some young adults reported dissatisfaction with physicians either in terms of the length of time spent with them or a lack of shared decision-making.[23] A recurring theme in terms of barrier was a lack of knowledge about asthma and asthma management.[22,188] Specifically, some people reported a lack of knowledge about how asthma medication works.[22] Indeed, some young adults did not take their medications because they did not perceive or

observe any benefits from using their controller medication.[189] Additionally, some perceived rescue medications to be more beneficial than controller medications.[189] Others indicated a negative perception towards their controller medication, which, serves as a barrier to medication taking.[13] Some young adults decide not to take their medication even when they have knowledge of asthma care regardless of what others think.[189] We also found that young adults felt overwhelmed from daily medication use.[13] Additionally, forgetfulness was frequently reported as a barrier to taking medications.[13,22,23,187,189] Decreased parental support to take medications as prescribed was an important factor in forgetfulness.[13] Young adults also experience lapses in insurance which may prevent them from filling prescriptions.[13,23] One study reported that young adults disliked paying for their asthma medications, and some people only purchase rescue medications as a result of cost.[22] Concerns about perceptions from peers also serves as a barrier with young adults detesting to carry their medication or spacer device around.[22,23] Negative beliefs such as believing to have control over asthma, expecting asthma to go away, being stubborn or strong-willed with decisions to not take medications, and irresponsibility in medication-taking were also identified as barriers.[13,189]

Enablers: Concepts pertaining to the use of cues to take medication, availability of social support, awareness of triggers, being motivated, and a knowledge of disease management were categorized as enablers. Admitting to the effectiveness of controller medications, admitting the chronic nature of asthma and acknowledging that failure to take controller medications leads to worsening symptoms were identified as enablers.[22,189] Being aware of asthma triggers, knowing what to do in terms of disease management, making efforts to learn about asthma management, and using alarms as cues to take medication were also identified as enablers.[188,189] Other enablers included taking parents' opinions about disease management into consideration and keeping the

future in perspective as a reason to fight for the positive outcomes associated with good disease management.[188,189]

Behaviors: The young adults in this review exhibited positive or negative behaviors. This includes positive behaviors, such as taking their medication as prescribed (e.g., taking controller medications daily and rescue medications in the event of acute symptoms).[189] Other positive behaviors included taking care of oneself, ensuring availability of medication, and enforcing a medication adherence strategy.[22,189] Behaviors that were categorized as negative include admitting to not taking medications or being rebellious about it, buying only rescue medications when short of cash, stopping medications when better, doubling up on medication depending on how they feel, or taking medications only when they have symptoms such as coughing.[13,22,23]

Outcomes: Results show that young adults living with asthma experience a range of outcomes. This review categorized outcomes that are typical of asthma as disease-specific, those that were at the level of the young adult as personal, and those that impact relationships with others as interpersonal. Disease-specific outcomes experienced by young adults include hyperventilation, having an exacerbation due to stress, having severe cough and breathing difficulties, chest tightness or breathlessness while performing certain activities, feeling sicker than others without asthma, becoming very afraid because of an exacerbation and experiencing side effects from asthma medications.[13,22,188] Outcomes that were categorized as interpersonal included facing stigma from people, being excluded from activities, feeling judged, facing family separations, or an inability to enjoy special moments with family members.[22,23] The participants also faced personal outcomes in response to asthma. This includes activity restrictions such as an inability to perform household chores, an inability to take part in hobbies such as farming, or an inability to train like an athlete or practice other exercise routines.[22,23,188] Other personal outcomes

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included changing jobs due to asthma or slowing down at work, feeling uncomfortable,

expressing anger towards asthma or feeling anger due to stigma, feeling different, feeling unsafe,

feeling fear in joining preferred career, and facing an inability to wear tight clothes as a result of

asthma.[22,23] Positive outcomes identified included feeling confident, feeling free of asthma, and a

lack of anger towards asthma.[22,188] These outcomes were used in constructing gain- and loss-

framed messages (Table 4.3). Other findings in the review were not used in message

development.

Table 4.3 Gain- and Loss-Framed Messages

#	**Gain-Framed Messages** (Group 1)	**Loss-Framed Messages** (Group 2)
1	Taking your daily inhaled medications as prescribed DECREASES breathlessness. Reply R to indicate receipt of message.	Failing to take your daily inhaled medications as prescribed INCREASES breathlessness. Reply R to indicate receipt of message.
2	You might feel MORE CONFIDENT by taking your daily inhaled meds as prescribed. Please reply R to indicate receipt of message.	You might feel LESS CONFIDENT by failing to take your daily inhaled meds as prescribed. Please reply R to indicate receipt of message.
3	Taking your daily inhaled meds consistently can DECREASE your fear of having flare-ups. Please reply R to indicate receipt of message.	Taking your daily inhaled meds inconsistently can INCREASE your fear of having flare-ups. Please reply R to indicate receipt of message.
4	Taking your daily asthma meds can INCREASE your chances of participating in a hobby you	Skipping your daily asthma meds can DECREASE your chances of participating in

	enjoy. Please reply R to indicate receipt of message.	a hobby you enjoy. Please reply R to indicate receipt of message.
5	Taking your daily inhaled medications DECREASES your chance to be uncomfortable because of asthma. Please reply R to indicate receipt of message.	Skipping your daily inhaled medications INCREASES your chance to be uncomfortable because of asthma. Please reply R to indicate receipt of message.
6	Taking your daily inhaled med can DECREASE feelings of anger at having asthma. Please reply R to indicate receipt of message.	Skipping your daily inhaled med can INCREASE feelings of anger at having asthma. Please reply R to indicate receipt of message.
7	You MAY ENJOY running when you take your daily asthma meds. Please reply R to indicate receipt of message.	You MAY NOT ENJOY running when you skip your daily asthma meds. Please reply R to indicate receipt of message.
8	You are more likely to dance with friends WITHOUT becoming breathless if you take your daily asthma meds. Please reply R to indicate receipt of message.	You are less likely to dance with friends WITHOUT becoming breathless if you fail to take your daily asthma meds. Please reply R to indicate receipt of message.
9	Take your daily inhaled medication and STOP FEELING SICKER than your friends. Please reply R to indicate receipt of message.	Skip your daily inhaled medication and KEEP FEELING SICKER than your friends. Please reply R to indicate receipt of message.
10	Taking your daily inhaled meds DECREASES breathlessness during workouts. Please reply R to indicate receipt of message.	Skipping your daily inhaled meds INCREASES breathlessness during workouts. Please reply R to indicate receipt of message.

11	You are LESS LIKELY to miss work or class because of asthma if you take your daily meds as prescribed. Please reply R to indicate receipt of message.	You are MORE LIKELY to miss work or class because of asthma if you don't take your daily meds as prescribed. Please reply R to indicate receipt of message.
12	You are LESS LIKELY to feel unsafe because of asthma if you take your daily asthma meds. Please reply R to indicate receipt of message.	You are MORE LIKELY to feel unsafe because of asthma if you fail to take your daily asthma meds. Please reply R to indicate receipt of message.
13	Taking your daily asthma meds significantly DECREASES your chances of feeling chest tightness. Please reply R to indicate receipt of message.	Skipping your daily asthma meds significantly INCREASES your chances of feeling chest tightness. Please reply R to indicate receipt of message.
14	Taking your daily inhaled meds as prescribed DECREASES your chances to be resentful about having asthma. Please reply R to indicate receipt of message.	Not taking your daily inhaled meds as prescribed INCREASES your chances to be resentful about having asthma. Please reply R to indicate receipt of message.
15	If you take your daily inhaled meds you would be MORE LIKELY to live a normal life. Please reply R to indicate receipt of message.	If you skip taking your daily inhaled meds you would be LESS LIKELY to live a normal life. Please reply R to indicate receipt of message.
16	Taking your asthma meds as prescribed can lead to LESS CHANCE of a flare-up due to stress. Please reply R to indicate receipt of message.	Not taking your asthma meds as prescribed can lead to GREATER CHANCE of a flare-

		up due to stress. Please reply R to indicate receipt of message.
17	You are LESS LIKELY to have a severe asthma cough if you take your daily asthma meds as prescribed. Please reply R to indicate receipt of message.	You are MORE LIKELY to have a severe asthma cough if you fail to take your daily asthma meds as prescribed. Please reply R to indicate receipt of message.
18	You are LESS LIKELY to have breathing difficulties if you take your daily inhaled meds. Please reply R to indicate receipt of message.	You are MORE LIKELY to have breathing difficulties if you fail to take your daily inhaled meds. Please reply R to indicate receipt of message.
19	You INCREASE your ability to have fun with family members if you take your asthma meds as prescribed. Please reply R to indicate receipt of message.	You DECREASE your ability to have fun with family members if you fail to take your asthma meds as prescribed. Please reply R to indicate receipt of message.
20	You INCREASE your chances of being able to perform chores If you take your asthma meds as prescribed. Please reply R to indicate receipt of message.	You DECREASE your chances of being able to perform chores If you fail to take your asthma meds as prescribed. Please reply R to indicate receipt of message.
21	You are INCREASING your chances of enjoying important moments with your friends by taking your daily asthma meds. Please reply R to indicate receipt of message.	You are DECREASING your chances of enjoying important moments with your friends by skipping your daily asthma meds. Please reply R to indicate receipt of message.

22	You are LESS LIKELY to be afraid of following your preferred career path if you take your daily inhaled medication. Please reply R to indicate receipt of message.	You are MORE LIKELY to be afraid of following your preferred career path if you don't take your daily inhaled medication. Please reply R to indicate receipt of message.
23	People are LESS LIKELY to exclude you from activities if you take your meds as prescribed. Please reply R to indicate receipt of message.	People are MORE LIKELY to exclude you from activities if you do not take your meds as prescribed. Please reply R to indicate receipt of message.
24	You are LESS LIKELY to feel judged because of asthma if you take your daily inhaled meds as prescribed. Please reply R to indicate receipt of message.	You are MORE LIKELY to feel judged because of asthma if you fail to take your daily inhaled meds as prescribed. Please reply R to indicate receipt of message.
25	You could INCREASE your ability to work out without having a flare-up if you take your daily asthma meds. Please reply R to indicate receipt of message.	You could DECREASE your ability to work out without having a flare-up if you fail to take your daily asthma meds. Please reply R to indicate receipt of message.
26	Taking your daily inhaled meds INCREASES your likelihood of bouncing back quickly when you experience a cold or flu. Please reply R to indicate receipt of message.	Skipping your daily inhaled meds DECREASES your likelihood of bouncing back quickly when you experience a cold or flu. Please reply R to indicate receipt of message.

Theory from findings: This review identified several needs pertaining to coping with asthma and asthma management among young adults. Many of the needs identified are common among other demographics living with asthma. However, those that may be unique to young adults include a desire to have autonomy over asthma and preferences on how information pertaining to asthma should be presented. A lack of knowledge about asthma and asthma management and negative perceptions of asthma medications are major barriers to asthma management among young adults. Barriers that may be unique to this demographic include a desire to fit in with peers, decreased parental support, and lapses in insurance as a result of aging out of parent's insurance. Knowledge, motivation, and adherence strategies may enable young adults to successfully manage their condition. Additionally, education on asthma and asthma management may address the negative behaviors exhibited by young adults living with asthma. Finally, young adults living with asthma exhibit a wide range of outcomes. The outcomes that may be unique to young adults include interpersonal outcomes that might hamper identity exploration, such as exclusion from activities that they care about especially by their peer. The emerging theory that this study posits is that young adults are more likely to exhibit positive behaviors with desirable outcomes (for example feeling confident) when their needs are met, adequate enablers are present, and barriers such as accepting the chronic nature of asthma have been removed (Figure 4.2). For example, young adults are confident and lack resentment towards asthma when they accept their condition, overcome barriers and receive relevant information and social support. Once, they accept their condition and know the disease, they are more consistent with their positive medication management behaviors with desired results.

4.2 Aim 2: To examine the effect of gain- and loss-framed messages on Beliefs, Intentions to take medications, Medication Adherence, and Asthma control.

The gain- and loss-framed messages developed in aim 1 were delivered to participants as text messages three times per week for two months with data collected at baseline, week four, and week eight. In the sections below, results from the framing intervention are reported beginning with the study enrollment and participants' demographic data followed by the effects of framing on Beliefs, Intentions, Medication Adherence, and Asthma Control.

4.2.1 Study Enrollment

A total of 43 participants were screened and recruited into the study over two batches (Figure 4.3). The first batch consisted of 38 participants enrolled in August 2019 while the second batch consisted of five participants enrolled in September 2019. As described in Chapter 3, study promotion approaches included the distribution of fliers across campus and a campus wide email invitation sent to students who were neither incoming nor outgoing students. Interested students were screened via a telephone conversation with the primary investigated (Appendix 3). A total of 81 students called the primary investigator to indicate interest in participating. Of those, four did not have asthma, four declined to participate in the study, 30 were either taking only a rescue medication or an oral preventer medication (e.g., Montelukast). Therefore, a total of 43 students were enrolled in the study. All 43 students contributed data at baseline, week four, and week eight.

Figure 4.3 CONSORT Flow Diagram


```
        ┌─────────────────────────┐
        │  Assessed for eligibility│
        │        (n =81)          │
        └────────────┬────────────┘
                     │              ┌──────────────────────────────────┐
                     │─────────────▶│   Excluded (n = 38)              │
                     │              │ * Does not have asthma (n =4)    │
                     │              │ * Declined to participate (n = 4)│
                     │              │ * Not taking an ICS (n = 30)     │
                     ▼              └──────────────────────────────────┘
        ┌─────────────────────────┐
        │   Randomized (n =43)    │
        └────────────┬────────────┘
         ┌───────────┴───────────┐
         ▼                       ▼
┌──────────────────┐   ┌──────────────────┐
│ Gain-frame (n=22)│   │ Loss-frame (n=21)│
└────────┬─────────┘   └────────┬─────────┘
         ▼                       ▼
┌──────────────────┐   ┌──────────────────┐
│ Three gain-framed│   │ Three loss-framed│
│ messages per week│   │ messages per week│
│   for 8 weeks    │   │   for 8 weeks    │
└────────┬─────────┘   └────────┬─────────┘
         ▼                       ▼
┌──────────────────┐   ┌──────────────────┐
│ Analyzed (n = 22)│   │ Analyzed (n = 21)│
└──────────────────┘   └──────────────────┘
```
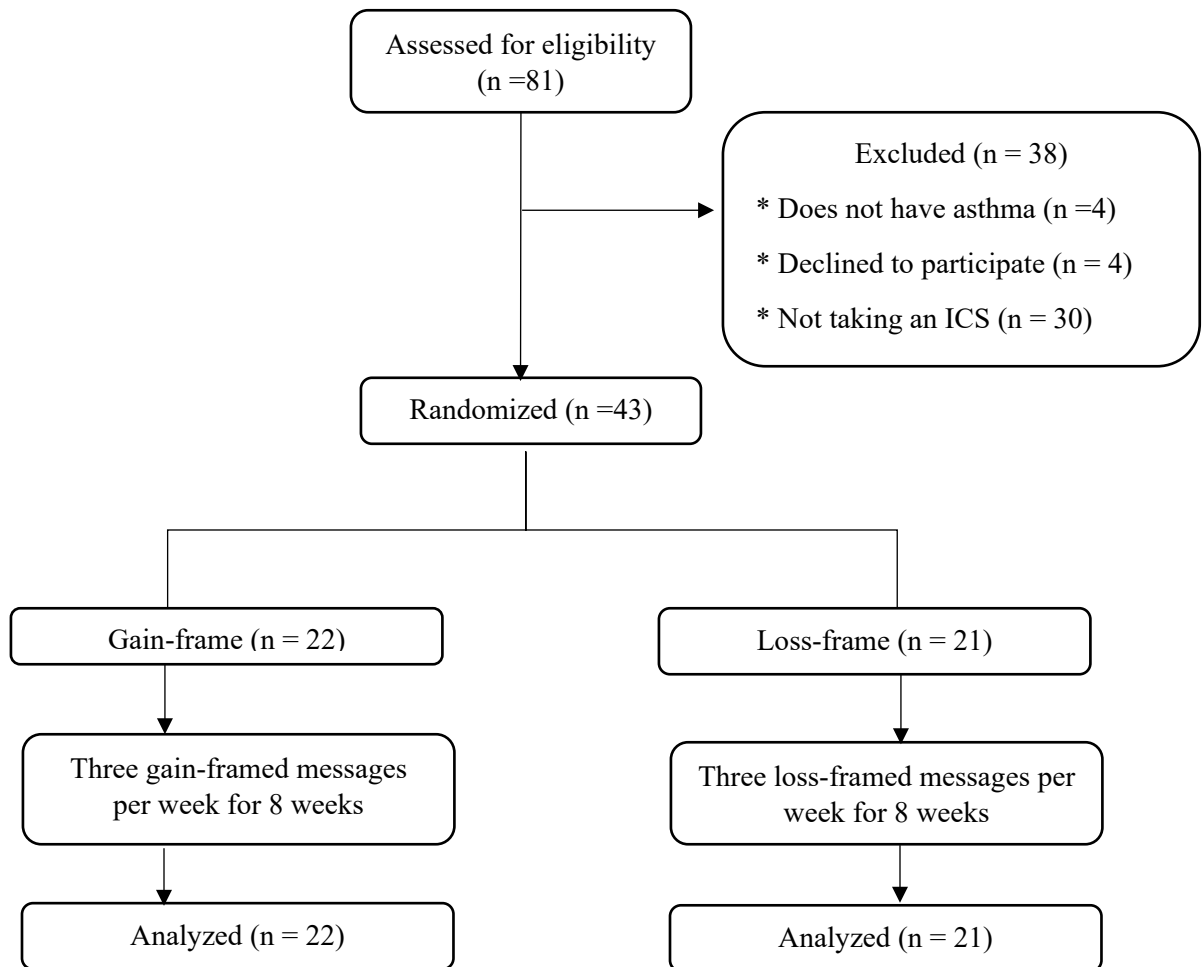
4.2.2 Descriptive Results

Characteristics of participants are displayed in Table 4.4. Most participants were female (60%), non-Hispanic (93%), white (90.7%), were diagnosed of asthma as a child (83.7%), had not missed school or work in the past month (81.4%) and had never smoked (88.4%). The mean age of participants was approximately 21. The mean asthma control was approximately 20, indicating that participants were controlled but with room for improvement since the minimum score for control is 20. Mean adherence was 3.52 with the maximum possible score being 5.0. At baseline, most participants believed in the necessity of their ICS for maintaining health. Among the present sample, there was a moderate amount of social desirability bias (mean score = 6.14). In a bivariate analysis, two variables (concerns measured at week eight and asthma control measured at week four) significantly correlated with social desirability bias (Table 4.5).

Table 4.4 Participants' Characteristics at Baseline

Categorical Variables[a]	n (%)			P-value
	Total (n = 43)	Gain-frame (n = 22)	Loss-frame (n = 21)	
Gender				
Male	14 (32.6)	8 (36.4)	6 (28.6)	0.586
Female	29 (67.4)	14 (63.6)	15 (71.4)	
Ethnicity				
Hispanic	3 (7.0)	2 (9.1)	1 (4.8)	0.578
Non-Hispanic	40 (93.0)	20 (90.9)	20 (95.2)	
Race				
Black or African American	3 (7.0)	2 (9.1)	1 (4.8)	
White	39 (90.7)	20 (90.9)	19 (90.5)	0.513
Others	1 (2.3)	0	1 (4.8)	
Smoking status				
Formerly smoked	5 (11.6)	5 (22.7)	0	
Currently smokes	0	0	0	**0.048**
Never smoked	38 (88.4)	17 (77.3)	21 (100)	

Length of asthma diagnosis				0.365
1 to 5 years ago	5 (11.6)	4 (18.2)	1 (4.8)	
Over 5 years ago	2 (4.7)	1 (4.5)	1 (4.8)	
Diagnosed as a child	36 (83.7)	17 (77.3)	19 (90.5)	
Average duration of missing work or school in the past month				
Did not miss work or school	35 (81.4)	18 (81.8)	17 (81.0)	
1 – 3 days	4 (9.3)	2 (9.1)	2 (9.5)	
4 – 6 days	0	0	0	
More than 7 days	0	0	0	0.997
Not in school or working past month	4 (9.3)	2 (9.1)	2 (9.5)	
Continuous variables[b]	**Mean (SD)**			
Age, years	20.86 (2.07)	20.36 (1.50)	21.38 (2.46)	0.107
Asthma control	19.77 (3.18)	20.18 (2.92)	19.33 (3.45)	0.389
Medication Adherence	3.52 (0.83)	3.47 (0.85)	3.57 (0.82)	0.701
Concerns about ICS	10.91 (4.24)	10.45 (4.34)	11.38 (4.19)	0.481
Perceived necessity of ICS	16.93 (4.9)	15.91 (5.44)	18.00 (4.12)	0.165
Necessity-concerns differential	6.02 (5.92)	5.45 (6.67)	6.62 (5.10)	0.525
Intentions to take ICS[c]	12.81 (2.63)	12.18 (3.17)	13.47 (1.75)	0.166
Social desirability bias	6.14 (1.57)	5.91 (1.60)	6.38 (1.53)	0.330

a For categorical variables, chi-square test was used in comparing the two groups.
b For continuous variables, independent t-test was used in the comparisons.
c computed with Mann Whitney due to outliers.
Significantly different values are marked in bold.

4.2.3 Study Retention and Engagement with Text Messages. There was a 100% retention of

participants that enrolled in the study. Also, all participants contributed data at the baseline,

month one, as well as the end of the study at month two. A total of 1,032 text messages were

successfully to delivered to participants. Participants' engagement with the text messaging

intervention was 85.9% as assessed by their response to each text message received during the

intervention. According to the texting platform, there were no errors or failures in message

delivery indicating a 100% transmission rate.

Table 4.5 Correlation among Demographic Variables, Social Desirability Bias, and Outcome Variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 SDB	-	.08	-.15	.06	.09	-.17	-.16	-.01	.12	**.37***	-.22	-.27	-.07	.04	-.15	-.05	-.14	-.08	**-.39***	-.17
2 Days of work, or school missed		-	.09	.05	-.06	.19	.30*	.22	.20	.18	.11	.05	.27	.26	.23	.27	.23	-.28	-.44**	-.36*
3 Ethnicity			-	.39**	-.42**	-.00	.20	.18	-.05	-.06	.20	.19	-.06	-.04	-.02	-.04	.16	-.17	-.11	.10
4 Sex				-	-.19	.19	.14	.20	-.25	-.24	.30	.33*	-.01	.12	.18	.19	.30	-.00	-.13	.02
5 Age					-	.14	.27	.24	-.05	.10	.26	.12	.14	.13	.15	.14	-.03	-.01	-.04	-.30
6 Type of NA						-	.47**	.45**	-.22	-.23	.54**	.53**	.64**	.45**	.99**	.86**	.74**	-.03	-.09	-.06
7 Necessity (b)							-	.83**	.17	.18	.71**	.54**	.56**	.47**	.45**	.52**	.49**	-.37*	-.34*	-.33*
8 Necessity-wk 8								-	.05	.14	.65**	.71**	.53**	.48**	.44**	.56**	.54**	-.30	-.31*	-.23
9 Concerns (b)									-	.69**	-.58**	-.46**	-.02	.06	-.24	-.07	-.02	-.18	-.13	-.05
10 Concerns-wk 8										-	.35**	-.60**	-.14	-.20	-.24	-.21	-.32*	-.30	-.38*	-.25
11 Differential (b)											-	.77**	.48**	.35*	.54**	.48**	.42**	-.16	-.19	-.24
12 Differential-wk8												-	.52**	.53**	.52**	.60**	.66**	-.03	.02	-.00
13 Intentions (b)													-	-72**	.66**	.62**	.47**	-.22	-.20	-.13
14 Intentions-wk 8														-	.46**	.60**	.61**	-.08	-.19	-.20
15 ADH (b)															-	.84**	.72**	-.06	-.13	-.11
16 ADH-wk 4																-	.85**	.03	-.07	-.04
17 ADH-wk 8																	-	.09	-.03	-.03
18 AC (b)																		-	.50**	.46**
19 AC - wk 4																			-	.52**
20 AC - wk 8																				-

* Correlation is significant at $p < 0.05$ level (two-tailed)

** Correlation is significant at $p < 0.01$ level (two-tailed)

NA: Nonadherence, (b): baseline, SDB: Social Desirability Bias, Differential: Necessity-concerns differential, ADH: Adherence, AC: Asthma control

4.2.4 Effects of Framing on Beliefs, Intentions, Medication Adherence, and Asthma Control

The first hypothesis associated with this aim was that participants receiving gain-framed messages will have more positive Beliefs about their medications, higher Intentions to take their medications as prescribed, greater Adherence to their medications, and greater Asthma control. The second hypothesis was that there will be a significant increase in positive Beliefs, Intentions, Medication Adherence, and Asthma control from baseline for participants receiving either gain- or loss-framed messages. The section below describes the effects of framing on each construct.

Effects on Beliefs: As described in Chapter 3, we performed a Two-way Mixed ANOVA to determine if Beliefs changed from baseline to the end of week eight between participants receiving gain- vs. loss-framed messages. There were no outliers as assessed by examination of studentized residuals for values greater than ±3. Beliefs were normally distributed as assessed by Normal Q-Q plot. Additionally, there was homogeneity of variance, as assessed by Levene's test of homogeneity of variance ($p > 0.05$). Box's test of equality of covariances was not applicable given that Beliefs were only measured at baseline and at the end of the study. There was no statistically significant interaction between the intervention and time on Beliefs ($F_{1, 41} = 0.233$, $p = 0.632$, $\eta_P^2 = 0.006$, Observed power = 0.08). The main effect of time on all participants was not significant ($F_{1, 41} = 2.385$, $p = 0.130$, $\eta_P^2 = 0.05$, observed power = 0.33) indicating that changes in Beliefs for all participants from baseline to the end of study was not significant. Also, there was no significant difference between participants receiving gain- versus loss-framed messages ($F_{1, 41} = 0.662$, $p = 0.421$, $\eta_P^2 = 0.02$, observed power = 0.13). The mean scores are shown in Figure 4.4 and Table 4.6.

Based on theory, type of nonadherence should impact the effect of framing on Beliefs. Therefore, we reran the analysis controlling for type of nonadherence. However, there was no difference in findings. Therefore, we rejected the alternate hypotheses (1a, 2a) and concluded that the intervention had no effect on participants' Beliefs about ICS.

Figure 4.4 Mean Score of Beliefs of Participants Receiving Gain- vs. Loss-Framed Messages
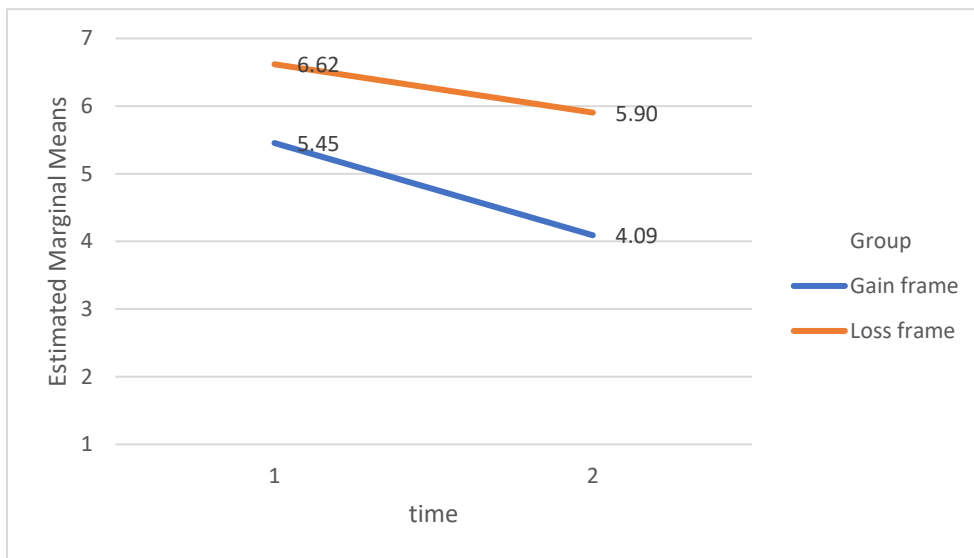
The comparison above was not statistically significant.

Table 4.6 Beliefs Score of Participants Across Different Timepoints

	Mean Beliefs Score (SD)		
Timepoint	All	Gain-frame	Loss-frame
Baseline	6.02 (5.91)	5.45 (6.67)	6.62 (5.10)
End of study	5.00 (6.78)	4.09 (7.46)	5.90 (6.02)

Significantly different values are marked in bold (there are none in this table).

Effects on Intentions: Exploratory factor analysis showed that all three items loaded on one factor, Intentions, with eigenvalue greater than 1. This factor explained 81.87% of the total variance. The intention scale had a high internal consistency with a Cronbach's Alpha of 0.886. A Two-way mixed ANOVA was performed to determine if Intentions differed from baseline to the end of the study between participants receiving gain- versus loss-framed messages. Outliers were identified by assessing studentized residuals with values greater than ±3. There was one outlier for baseline Intentions with a studentized residual value of -3.65. There were two outliers for endpoint Intentions with studentized residual values of -3.55 and -3.39. Upon assessment of normality, by plotting the studentized residuals, there was a negative skew with both baseline and endpoint Intentions. Therefore, we took out the outliers and repeated the normality test. This time, both measurements of Intentions were normally distributed. Also, the assumption of homogeneity was met as assessed by Levene's test of homogeneity of variance ($P > 0.05$). There was no statistically significant interaction between the intervention and time ($F_{1, 38} = 1.094$, $p = 0.302$, $\eta_P^2 = 0.027$, observed power = 0.18).

There was no statistically significant difference in Intentions from baseline among participants receiving gain- versus loss-framed messages ($F_{1, 38} = 0.746$, $p = 0.393$, $\eta_P^2 = 0.019$, observed power = 0.13). The mean Intention score of participants at different time points are shown in Figure 4.5 and Table 4.7. We expected the type of nonadherence to have an impact on Intentions therefore we repeated the analysis to determine if Intentions changed from baseline to the end of study among participants receiving gain- versus loss-framed message controlling for level of Intentional nonadherence. There was no statistically significant interaction between the intervention (gain- versus loss-frame messages) and time. However, the main effect of time was significant after controlling for level of Intentional nonadherence, indicating that there was a

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statistically significant difference in the level of Intentions of all participants from baseline ($M =$ 13.12, $SD = 2.14$) to end of study ($M = 13.37$, $SD = 1.73$) ($F_{1, 38} = 8.585$, $p = 0.006$, $\eta_p^2 = 0.184$, observed power = 0.82). The covariate, level of intentional nonadherence was statistically significantly related to time ($F_{1, 38} = 7.788$, $p = 0.008$, $\eta_p^2 = 0.170$, observed power = 0.78).

In all, we reject the alternate hypothesis that Intentions to take ICS as prescribed differed between participants receiving gain- versus loss-frame messages (hypothesis 1b). However, we fail to reject the alternate hypothesis that participants' Intentions to take their medication as prescribed improved from baseline (hypothesis 2b).

Figure 4.5 Mean Score of Intentions at Baseline and End of Study
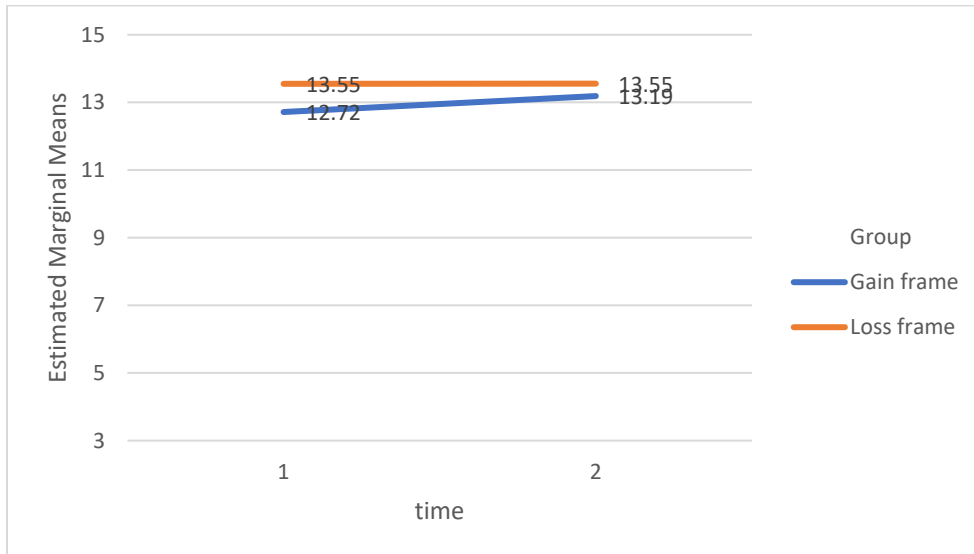
Table 4.7 Intentions Score of Participants Across Different Timepoints

		Mean Intention Score (SD)		
Timepoint	**All (Unadjusted)**	**All (after adjusting for level of nonadherence)***	**Gain-frame**	**Loss-frame**
Baseline	12.93 (2.61)	**13.12 (2.14)**	12.18 (3.17)	13.48 (1.75)

| End of study | 12.81 (2.63) | **13.37 (1.73)** | 12.73 (2.62) | 13.14 (2.65) |

Significantly different values are marked in bold.
* Level of intentional nonadherence was used as a covariate in 2-way mixed ANOVA

Effect on Medication Adherence: A mixed model ANOVA was used in determining if

participants' medication-taking behavior differed from baseline, one month or two months after

receiving gain- and loss-framed messages. There were no outliers as assessed by examination of

studentized residuals for values greater than ±3. Adherence was normally distributed as assessed

by Normal Q-Q plot. Additionally, there was homogeneity of variance, as assessed by Levene's

test of homogeneity of variance ($p > 0.05$). Box's test of equality of covariances indicated that

the observed covariance matrices of Adherence were equal across groups ($p = 0.610$). Mauchly's

test of sphericity indicated that the assumption of sphericity was violated ($p = 0.002$): therefore,

the Greenhouse-Geisser correction was applied. There was no significant interaction between the

experimental condition (gain- vs. loss-framed messages) and the time of measurement (baseline,

one month, two months) of Adherence ($F_{1.584, 64.94} = 0.98$, $p = 0.363$, $\eta_P^2 = 0.023$, observed power

$= 0.20$). The mean Adherence score of participants across the different timepoints are shown in

Figure 4.6 and Table 4.8.

There was no significant difference in Adherence levels based on whether participants

received a gain- or loss-framed message ($F_{1, 41} = 0.48$, $p = 0.492$, $\eta_P^2 = 0.012$, observed power =

0.10). Furthermore, there was no significant difference in Adherence levels from baseline across

month one and two ($F_{1.584, 64.94} = 0.20$, $p = 0.764$, $\eta_P^2 = 0.005$, observed power = 0.08).

Therefore, we reject the alternate hypothesis that participants receiving gain-framed messages

would have greater Adherence to their medications (hypothesis 1c). We also reject the alternate

hypothesis that participants Adherence would improve at the end of the study compared to baseline (hypothesis 2c).

Figure 4.6 Mean Score of Medication Adherence at Baseline, Month 1, and Month 2
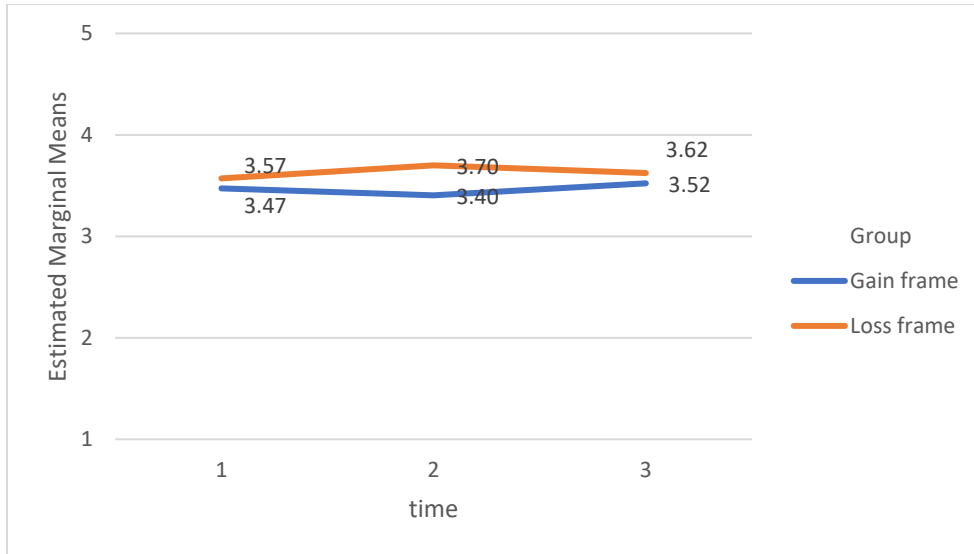
Table 4.8 Medication Adherence Score of Participants Across Different Timepoints

	Mean Medication Adherence Score (SD)		
Timepoint	**All**	**Gain-frame**	**Loss-frame**
Baseline	3.52 (0.83)	3.47 (0.85)	3.57 (0.82)
Month1	3.55 (0.80)	3.40 (0.80)	3.70 (0.79)
Month 2	3.57 (0.87)	3.52 (0.83)	3.62 (0.93)

Significantly different values are marked in bold (there are none in this table).

Effect on Asthma Control: We used a mixed model ANOVA to determine if participants' asthma control differed before and after the framing intervention among participants receiving gain- versus loss-framed messages. There were no outliers as assessed by examination of

studentized residuals for values greater than ±3. Asthma control was normally distributed as assessed by Normal Q-Q plot. Additionally, there was homogeneity of variance, as assessed by Levene's test of homogeneity of variance ($p > 0.05$). Box's test of equality of covariances indicated that the observed covariance matrices of adherence was equal across groups ($p = 0.298$). The assumption of sphericity was met as assessed by Mauchly's test of sphericity ($p > 0.05$). There was no significant interaction between the experimental condition (gain- vs. loss-framed messages) and time of measurement (baseline, month 1, and month 2) of asthma control ($F_{2,82} = 0.139$ $p = 0.871$ $\eta_P^2 = 0.003$ observed power = 0.07).

There was no significant difference in asthma control based on whether a participant received gain- versus loss-framed messages ($F_{1, 41} = 1.254$, $p = 0.269$, $\eta_P^2 = 0.030$ observed power =0.19). Participants asthma control differed one month after the intervention and at the end of the intervention compared to baseline ($F_{2, 82} = 3.342$, $p = 0.040$, $\eta_P^2 = 0.075$, observed power = 0.62). Participants had a greater asthma control two months ($M = 20.923$, $SE = 0.40$) after the intervention compared to one month ($M = 19.940$, $SE = 0.53$) after the intervention ($p = 0.043$). Also, they had greater asthma control two months ($M = 20.923$, $SE = 0.40$) after the intervention compared to baseline ($M = 19.758$, $SE = 0.49$) ($p = 0.018$). The mean asthma control scores across all time points are shown in Figure 4.7 and Table 4.9. About 7.5% of the variance in asthma control was explained by the framed messages ($\eta^2 = 0.075$).

Among the present sample, participants had a greater asthma control after the framing intervention whether they received gain- or loss-framed messages. A summary of results for Aim 2 are described in Table 4.10. We reject the alternate hypothesis that asthma control would differ among participants receiving gain- versus loss-framed messages (hypothesis 1d). On the other

hand, we fail to reject the alternate hypothesis that asthma control would improve from baseline, at the end of the study (hypothesis 2d).

Figure 4.7 Mean Score of Asthma Control over Baseline, Month 1, and Month 2
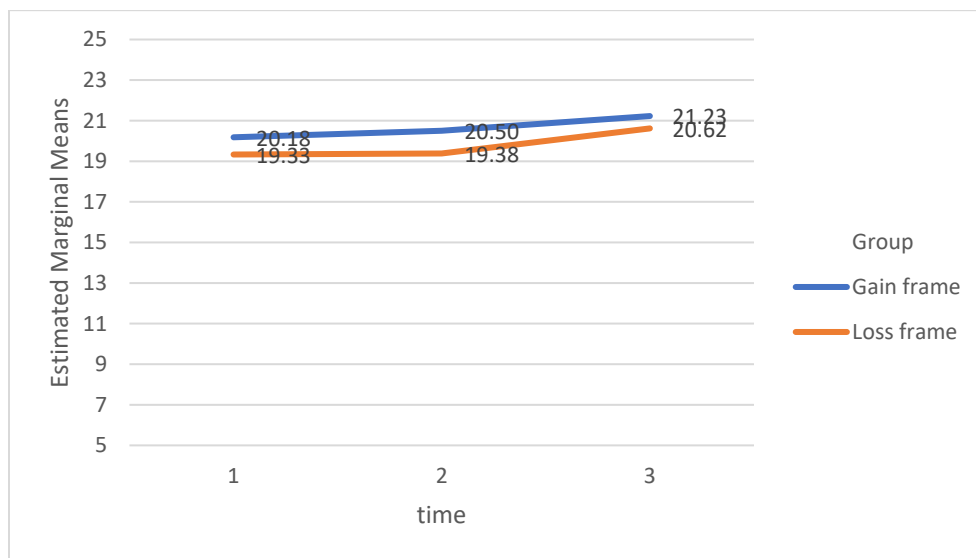
Table 4.9 Asthma Control Score of Participants Across Different Timepoints

	Mean Asthma Control Score (SD)		
Timepoint	**All**	**Gain-frame**	**Loss-frame**
Baseline	**19.77 (3.18)**	20.18 (2.92)	19.33 (3.45)
Month1	**19.95 (3.45)**	20.50 (3.35)	19.38 (3.54)
Month 2	**20.93 (2.63)**	21.23 (2.20)	20.62 (3.04)

Significantly different values are marked in bold.

Table 4.10 Summary of Results for Aim 2

Hypotheses	**Result**	**Decision**

1a, 2a	1) There was no significant difference in Beliefs between those receiving gain- versus loss-framed messages 2) Changes in mean score of Beliefs from baseline to the end of the study was not significant,	1a, 2a - Reject the alternate hypotheses
1b, 2b	1) Intentions did not differ between participants receiving gain- versus loss-framed messages 2) Intentions increased from baseline among all participants at the end of the study	1b – Reject the alternate hypothesis 2b – Fail to reject the alternate hypothesis
1c, 2c	1) There was no significant difference in Medication Adherence between those receiving gain- versus loss-framed messages 2) Changes in mean score of Medication Adherence from baseline at the end of the study was not significant	1c, 2c – Reject the alternate hypotheses
1d, 2d	1) Asthma control did not differ between participants receiving gain- versus loss-framed messages 2) Asthma control improved from baseline among all participants at the end of the study	1c – Reject the alternate hypothesis 2d – Fail to reject the alternate hypothesis

Effect on Asthma Control using the Minimally Important Difference (MID): We also

examined the proportion of individuals who achieved an MID three units from baseline to month

one, month one to month two, and baseline to month two using descriptive statistics.

Additionally, we used the chi square statistics to compare the proportion of individuals achieving

a minimally important difference among those receiving gain- versus loss-framed messages at

month one and month two.

The proportion of individuals with a minimally importance difference of three are

displayed in Figure 4.8. Furthermore, there were no significant differences in Asthma control

among those receiving gain- versus loss-framed messages at month one and month two (Table 4.11). Therefore, our previous conclusions (Table 4.10) did not change.

Figure 4.8 Proportion of Participants Achieving MID of Three Across Timepoints
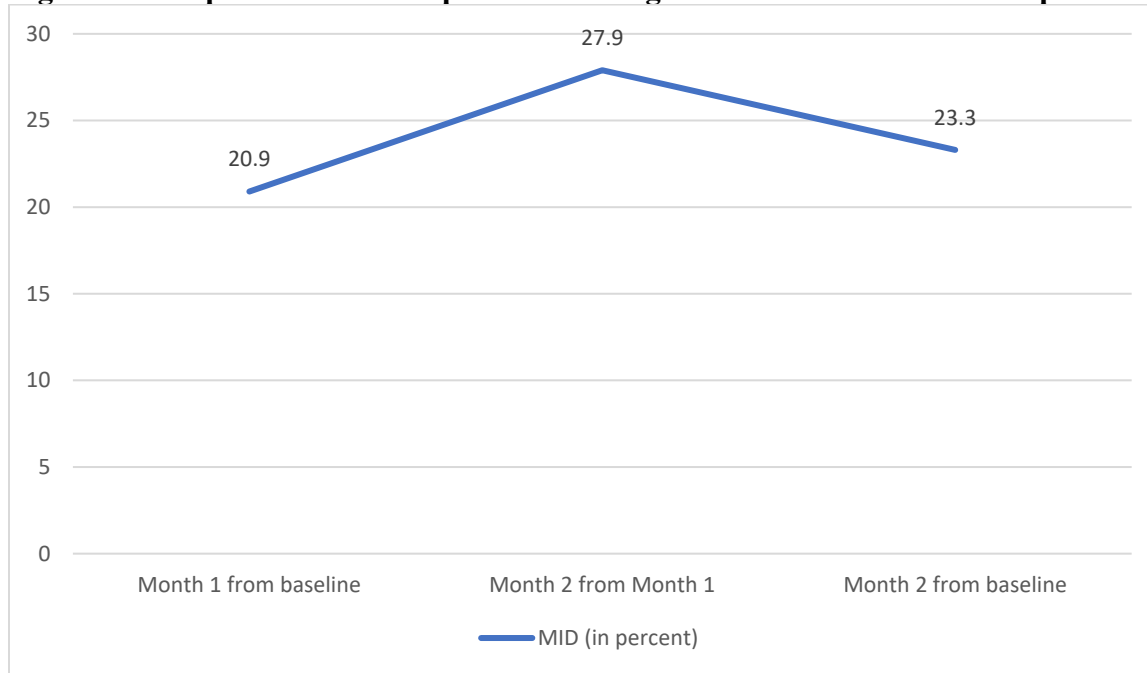
Table 4.11 Proportion of Participants in Gain- vs. Loss-Framed Conditions Achieving MID

	Mean Asthma Control Score (SD)			
Timepoint	All	Gain-frame	Loss-frame	P-value
Month 1 from baseline	**9**	4	5	0.650
Month 2 from Month 1	**12**	6	6	0.924
Month 2 from baseline	**10**	6	4	0.523

4.3 Aim 3: To examine associations between Message Frame, Beliefs, Intentions, Medication Adherence, and Asthma Control.

Preliminary Analysis: A preliminary bivariate analysis (Table 4.5) found several significant relationships between hypothesized variables. For instance, Beliefs measured at baseline and at the end of study were both positively correlated with Adherence measured at baseline, month 1, and month 2. There were significant relationships between perceived necessity of ICS and concerns that participants had about their ICS. There were positive correlations between perceived necessity and Adherence as well as a negative correlation between concerns and adherence. As expected, there were significant positive correlations between Beliefs and Intentions. There was no significant correlation between Adherence and Asthma Control.

Path Analysis: We utilized a path analysis model to understand the relationship between Asthma control, Medication Adherence, Intentions to take medications, Beliefs, and framing. As path analysis is sensitive to outliers and missing data, we chose not to delete outliers. Instead, the three outliers observed in the baseline and endpoint Intentions variable were Winsorized (replace each extreme value with the next largest observation in the dataset that is not an outlier).[190] The initial model (Figure 4.9) did not have a good fit (χ^2 (5) = 13.144, p = 0.022, CMIN = 13.144, RMSEA = 0.197). A non-significant Chi square value indicates good model fit.[191] Also, a Root Mean Square Error of Approximation (RMSEA) of less than 0.08 indicates a good model fit while an RMSEA of 0.08 indicates mediocre fit.[191] The arrows in the model indicate a direct effect of each variable on an endogenous variable. Each circle represents the error in the prediction of an endogenous variable with the standard deviation written by the circle.

The modification indices test suggested adding a path from Beliefs to Adherence. Also, due to the non-significance of the path from message frame to Intentions, we dropped the path.[192] This modification (Figure 4.10) improved the model significantly (χ^2 (5) = 2.829, p = 0.726, CMIN = 2.829, RMSEA < 0.001). The standardized total (sum of direct and indirect effects), direct (a direct relationship between variables without considering mediated effects), and indirect (mediated effects) effects are shown in Table 4.12. In the second model, framing exhibits a small but non-significant effect on Beliefs (0.135). Also, Beliefs exert a large direct effect on Intentions (0.571), a medium direct effect on Adherence (0.439), and a medium indirect effect on Adherence mediated by Intentions (0.222). The direct effect of Beliefs on Intentions was medium (0.387) (Table 4.12).

We also performed an identical path analysis with baseline data to compare the models obtained at baseline versus end of study (Figure 4.11). The model had a mediocre fit (χ^2 (5) = 6.372, p = 0.272, CMIN = 6.372, RMSEA = 0.08), which is acceptable. The summary of standardized total, direct, and indirect effects are described in Table 4.13. The standardized parameter estimates of the path from Beliefs to Intentions increased at the end of study (0.571) compared to baseline (0.479). Similarly, the standardized parameter estimates of the path from Beliefs to Adherence increased at the end of study (0.439) compared to baseline (0.295). However, the standardized parameter estimates of the path from Intentions to Adherence decreased at the end of the study (0.387) compared to baseline (0.520). A summary of significant and non-significant effects at baseline versus end of study are shown in Table 4.14 and Table 4.15. In summary, we failed to reject the following alternate hypotheses: 4b) Beliefs will have a direct positive relationship with Intentions, and, 5) Intentions will mediate the effects of Beliefs on Adherence. A summary of decisions for Aim 3 is described in Table 4.16.

Figure 4.9 Path Analysis of the Effect of Framing on Beliefs, Intentions, Adherence, and Asthma Control (Model 1)
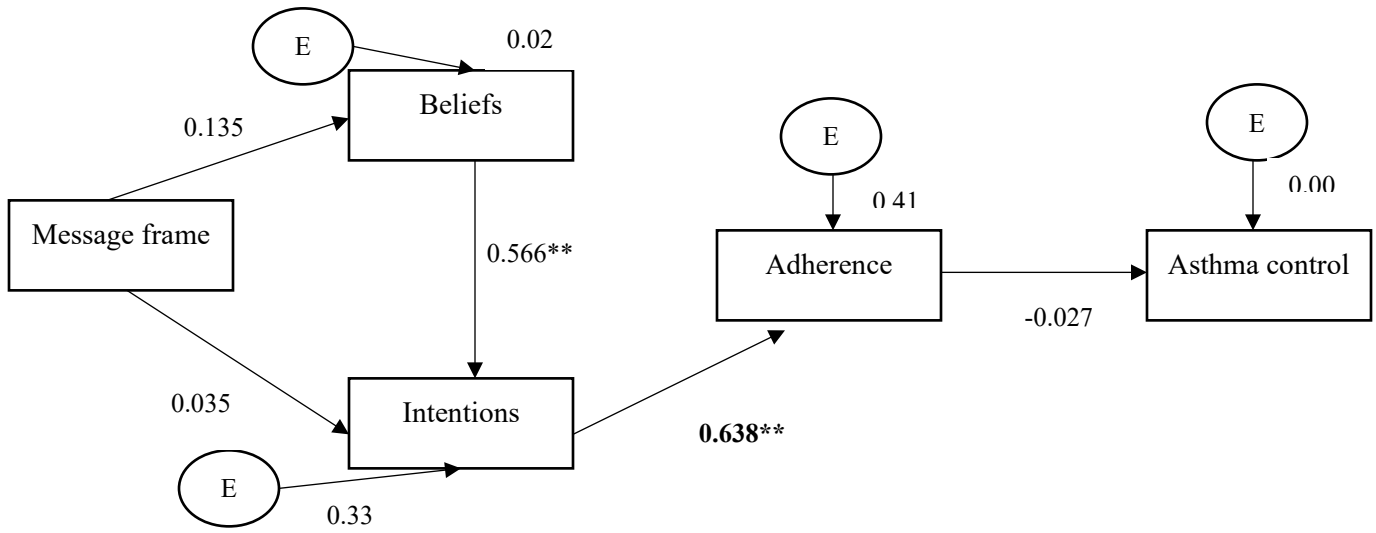
Figure 4.10 Modified Path Analysis of the Effect of Framing on Beliefs, Intentions, Adherence, and Asthma Control (Model 2)
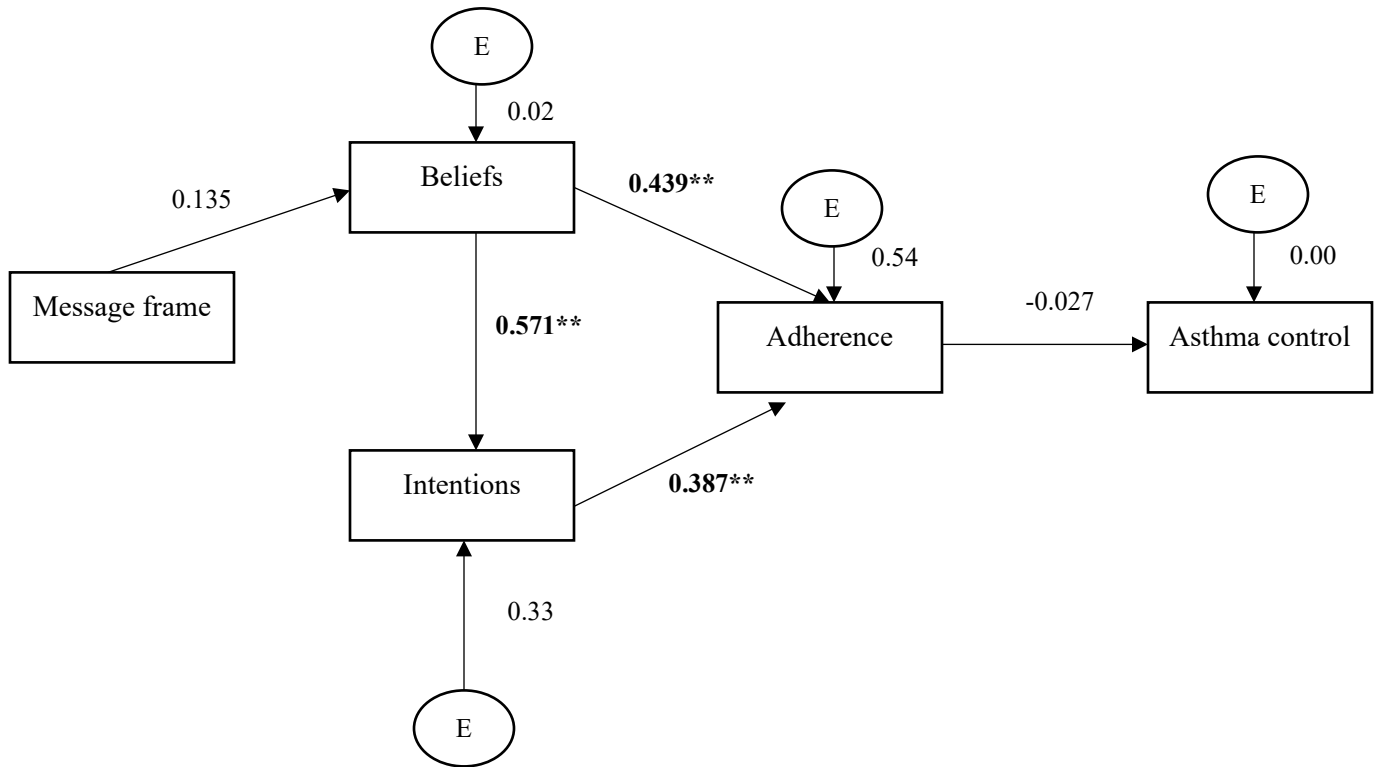
Table 4.12 Standardized Total, Direct, and Indirect Effects of Model 2

	Message frame	Beliefs	Intentions	Adherence
Standardized Total Effects				
Beliefs	0.135	0.000	0.000	0.000
Intentions	0.077	0.571*	0.000	0.000
Adherence	0.089	0.660*	0.387*	0.000
Asthma control	-0.002	-0.018	-0.010	-0.027
Standardized Direct Effects				
Beliefs	0.135	0.000	0.000	0.000
Intentions	0.000	0.571*	0.000	0.000
Adherence	0.000	0.439*	0.387*	0.000
Asthma control	0.000	0.000	0.000	-0.027
Standardized Indirect Effects				
Beliefs	0.000	0.000	0.000	0.000
Intentions	0.077	0.000	0.000	0.000
Adherence	0.089	0.221*	0.000	0.000
Asthma control	-0.002	-0.018	-0.010	0.000

* Two-tailed significance (p-value < 0.05) at 95% confidence interval

Figure 4.11 Comparative Path Analysis of the Effect of Framing on Beliefs, Intentions, Adherence, and Asthma Control using Baseline Data (Model 3)
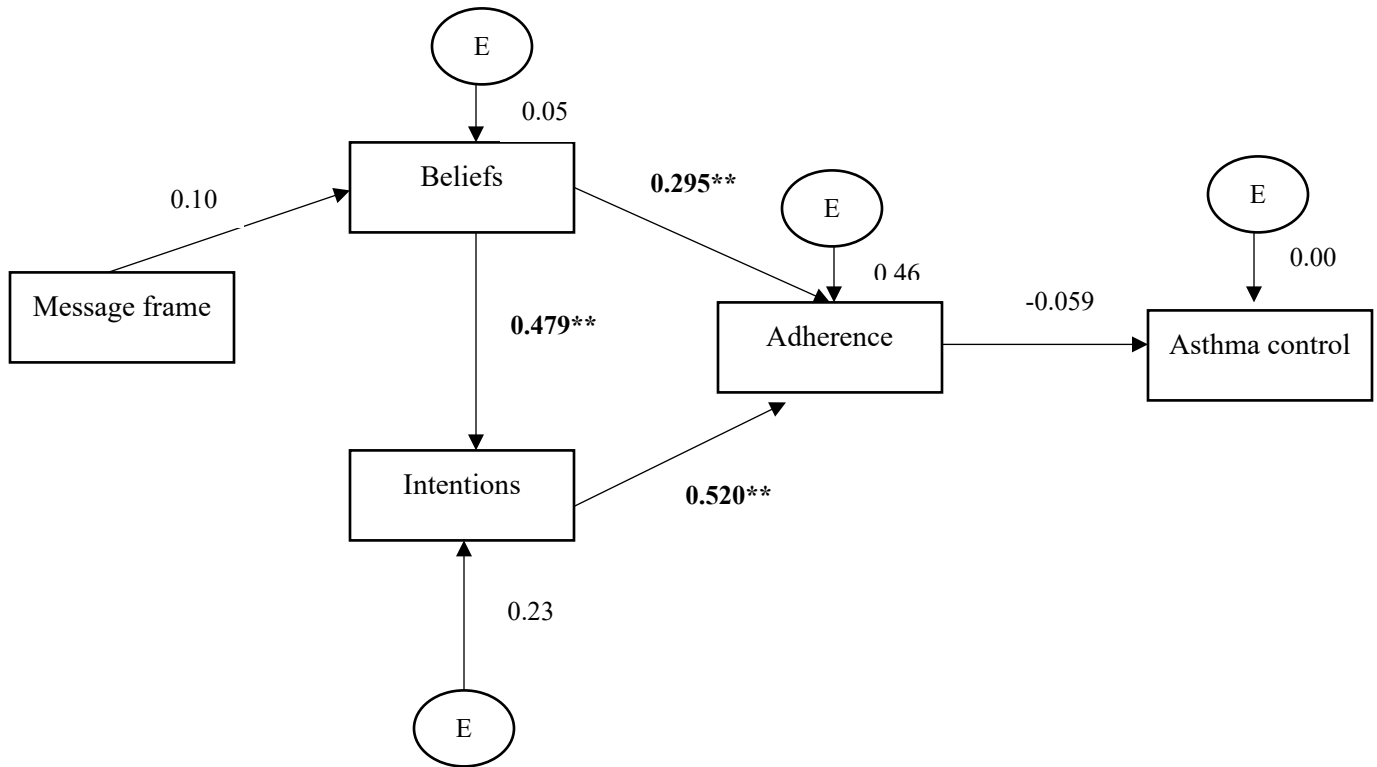
Table 4.13 Standardized Total, Direct, and Indirect Effects of Model 3 (baseline)

	Message frame	Beliefs	Intentions	Adherence
Standardized Total Effects				
Beliefs	0.100	0.000	0.000	0.000
Intentions	0.048	0.479*	0.000	0.000
Adherence	0.054	0.544*	0.520*	0.000
Asthma control	-0.003	-0.032	-0.030	-0.059
Standardized Direct Effects				
Beliefs	0.100	0.000	0.000	0.000
Intentions	0.000	0.479*	0.000	0.000
Adherence	0.000	0.295*	0.520*	0.000
Asthma control	0.000	0.000	0.000	-0.059
Standardized Indirect Effects				
Beliefs	0.000	0.000	0.000	0.000
Intentions	0.048	0.000	0.000	0.000
Adherence	0.054	0.249*	0.000	0.000
Asthma control	-0.003	-0.032	-0.030	0.000

* Two-tailed significance (p-value < 0.005) at 95% confidence interval

Table 4.14 Summary of Significant Effects at Baseline vs. End of Study

Paths	Baseline		End of Study	
	β weight	P-value	β weight	P-value
Beliefs → Intentions	0.479	<0.001	0.571	<0.001
Beliefs → Adherence	0.295	0.017	0.439	<0.001
Intentions → Adherence	0.520	<0.001	0.387	0.003

Table 4.15. Summary of Non-significant Effects at Baseline vs. End of Study

Paths	Baseline		End of Study	
	β weight	P-value	β weight	P-value
Message Frame Group → Beliefs	0.100	0.517	0.135	0.376
Adherence → Asthma Control	-0.059	0.704	-0.027	0.861

Note: Beliefs is the differential between concern and necessity of ICS as perceived by participants.

Table 4.16 Summary of Results for Aim 3

Hypothesis	Results	Decision
3	Framing had a non-significant direct relationship with Beliefs and Intentions	Reject the alternate hypothesis
4a	Beliefs did not mediate the effects of framing on Intentions	Reject the alternate hypothesis
4b	Beliefs had a direct positive relationship with Intentions	Fail to reject the alternate hypothesis
5	Intentions mediated the effects of Beliefs on Adherence, Beliefs had a direct positive relationship with Adherence	Fail to reject the alternate hypothesis
6	Adherence did not have a direct positive relationship with Asthma control	Reject the alternate hypothesis

CHAPTER 5: DISCUSSION

The objectives of this study were to 1) identify outcomes of asthma relevant to young adults through the synthesis of qualitative literature exploring what it means to live with asthma as a young adult, 2) examine the effects of gain- and loss-framed messages on participants Beliefs about ICS, Intentions to take ICS as prescribed, Medication Adherence, and Asthma Control, and, 3) examine the hypothesized relationship between Message Frame, Belief, Intentions, Medication Adherence, and Asthma Control. The outcomes of the first objective were used in constructing gain- and loss-framed messages promoting the use of daily inhaled corticosteroids (ICS). Objective two was accomplished through a framing-intervention that delivered gain- and loss-framed messages to participants randomized to receive gain- and loss-framed messages, respectively. The intervention was two months long and outcomes were measured at baseline, month 1, and month 2. The third objective was accomplished using path analysis, which tested a hypothesized conceptual model based on the Theory of Planned Behavior. This chapter discusses the implication of findings by aim.

5.1 Aim 1

This first part of this aim involved a systematic review and qualitative meta-synthesis of qualitative literature focusing on the experience of living with asthma as a young adult. Five categories of concepts emerged: 1) Needs, 2) Barriers, 3) Enablers, 4) Behaviors, and 5) Outcomes. Each category will be discussed in the following sections.

Needs: We found that young adults have informational needs regarding asthma, asthma management, weather and pollen with preferences for information to be presented visually. This is consistent with findings from existing literature exploring the informational needs of

individuals living with asthma.[193,194] Young adults also need parental support, and support from healthcare providers in the management of asthma. They would like the public to be educated on asthma so that others can understand how to help in cases of acute symptoms. Previous studies have also identified the need for emotional social support where empathy and moral support are given and instrumental social support where individuals could be supported during exacerbations or aided in obtaining medications.[194]

Researchers could leverage these findings to develop educational materials, programs, or other interventions pertaining to asthma and asthma management for a young adult audience. These programs could focus on providing information about asthma, its triggers, and management. Also, digital tools that support asthma management or living with asthma by providing updates on weather and pollen will help this population. As an example, a self-management smartphone app that takes the preferences of young adults into consideration could be potentially very helpful.[195]

Furthermore, young adults have expressed a desire for autonomy over asthma. Specifically, they would like to make decisions over disease management including adjusting the dose to suit their perceived needs and discontinuing medications, which could stem out of a fear of dependency.[13] This emphasizes the need for shared decision-making between providers and young adults with asthma. Shared decision-making between providers and young adults with asthma is a topic that is yet to be explored.

Barriers: The barriers that emerged in this review include a dissatisfaction with physicians either because of the length of visits or a lack of shared decision-making. This is unsurprising given that dissatisfaction with length of visits as well as a lack of shared decision-making has been

trending in the literature.[23,66,133,196,197] In terms of length of stay, young adults have complained about being rushed during visits without having adequate conversations.[23,66]

Consistent with our findings, previous research identified a need for a sense of partnership between the patient and provider with this need causing frustration for young adults with asthma.[133] Advocates of patient centered care have encouraged patient involvement in every aspect of care to promote shared decision making which will in turn improve medication adherence and patients' health outcomes.[196,197] In shared decision-making, patients and clinicians share information, articulate treatment preferences, discuss the options, and agree on the treatments to utilize.[197] Patient focused technology such as mHealth apps that empower the patient for visits by suggesting possible topics or questions to discuss with physicians may be helpful in making encounters with physicians more meaningful.[198] Furthermore, mHealth apps that records the patients' health outcomes (e.g. asthma control over time or medication-taking behavior) may also be helpful in overcoming barriers to meaningful conversations with the physician.[198,199] Clinicians perceive access to these patient-generated data via mHealth apps as beneficial to patient-centered clinical encounters.[199]

Apart from facilitating patient-centered encounters and creating meaningful conversations with the provider, shared decision-making on treatment options may also ensue. For example, if a patient taking an oral controller medication makes it known to his physician that he is uncomfortable with oral medications, then he could be switched to an inhaled medication that accomplishes the same purpose. Considering the patients' preference may impact their medication-taking behavior which can impact their asthma control.[197]

Consistent with existing literature, a lack of knowledge about asthma and asthma management was also a barrier; some young adults do not know how their medication works while others have negative perceptions of their medications or do not perceive their medication to have a benefit.[133] Education about asthma and asthma management may help address issues related to beliefs, attitudes, and knowledge of asthma, as well as improve patients' use of asthma medications.[134] Independent of a lack of knowledge, some young adults decide to not take their medications regardless of what people think. This behavior has been described as intentional nonadherence in the literature.[135] Again, this finding emphasizes a need for shared decision-making in the management of young adults with asthma.

Findings from this review also indicated that young adults are overwhelmed with daily medication use with forgetfulness frequently reported as a reason for poor asthma management. Simplification of treatment plans, reduction of doses or the use of combined formulations of medication from different classes as well as reminders or other behavioral interventions may help.[134] While young adults also experience decreased parental support in disease management, our findings indicate that young adults still need support from parents in asthma management.[188,19] This is a key factor in their adherence to controller medications as children and adolescents.[188] Another barrier experienced by young adult is lapses in insurance as well as the cost of the medication. Although the Patient Protection and Affordable Care Act has partly decreased uninsurance among young adults by prolonging dependency on parents' insurance plans, lapses still exist.[200] Furthermore, individuals in this age group may need guidance on how to navigate the health insurance system, with needs ranging from education about insurance terms to choosing a plan with appropriate benefits and cost-sharing.[21]

We also identified concerns about the perception of peers as a barrier to medication-taking. According to previous studies, young adults with asthma were ready to deny having the disease, did not like to be reminded of their "handicap" by friends and family, and would stop taking their medications to look cool among peers.[23,201] Expectations that asthma will go away, irresponsibility in medication-taking, and believing to have control over asthma also served as barriers. It is likely that education about asthma and asthma management may be able to ameliorate this problem.

Enablers: This review identified acceptance of the chronic nature of asthma as an enabler to appropriate medication-taking behaviors. When individuals believe that asthma is acute they are more likely to engage in episodic management of asthma.[50] Partnering with a physician to follow guideline recommended care is what is needed to achieve a healthy active life with asthma, rather than episodic management.[125] This misconception of the nature of asthma may be corrected by asthma education.

For example, the Australian National Asthma Council guidelines for young adults recommends that even when young adults taking regular controller medications are controlled for at least three months, the medication should not be stopped.[202] Rather, it suggests that physicians should consider reducing the dose or stepping down treatment while monitoring. This consensus-based expert guideline suggests that a trial discontinuation of controller medication may be considered when the young adult with asthma has been on the lowest possible dose of a controller medication and has been well controlled for at least 3 months.[202] However, the Global Initiative on Asthma (GINA) guideline, which is based on evidence is very clear in its recommendation that controller medications should not be discontinued in adults and adolescents

except to temporarily confirm the diagnosis of asthma.[203] Similarly, EPR-3 recommends maintaining the patient on the least possible dose of ICS necessary to maintain control.

Motivation to learn about asthma management, knowledge about disease management, as well as understanding the role of controller medications were identified as enablers of adherence to prescribed medications. It is possible that the presence of social support and asthma education may help in fostering motivation and knowledge of disease management among young adults.[119,134] Social support which may be practical (physical aid), emotional, or a combination of both (unidimensional social support) may be given by peers, parents or guardians, and healthcare providers.[119,204]

Also categorized as helpful to young adults living with asthma was an awareness of triggers of asthma exacerbation. Pollen, indoor allergens such as house dust mites, molds, pets, cockroaches, and active or passive smoking are examples of asthma triggers.[205] Identifying triggers and avoiding them may help young adults to cope better with the disease.[205] Furthermore, consideration of parents' opinion on disease management was also identified as an enabler for disease management. Although young adults are mostly independent with decreased parental support, parents can still leverage technology to support their children with disease management. Self-management apps that allows young adults to share their medication-taking behavior as well as asthma control with others may be helpful in facilitating parental support, thus enabling them to properly manage their asthma.

Behaviors: This review identified positive and negative behaviors among young adults living with asthma. Behaviors that were categorized as positive include taking care of ones' self, ensuring availability of medications, and enforcing a medication adherence strategy. Behaviors

that were categorized as negative include being careless about taking medications, being rebellious about medication taking, intentionally stopping or doubling medications, and taking medications only when symptoms are present. Our findings highlight the different intentional behaviors demonstrated by young adults, which are a result of active decision-making. Interventions that promote positive decision-making, such as shared decision-making may be helpful. There is evidence that shared decision-making promotes adherence and health outcomes among individuals with poorly controlled asthma.[197]

Outcomes: This review categorized outcomes that are typical of asthma as, "disease-specific". Outcomes that reflected individuals' direct response to living with asthma were referred to as, "personal", while those that impacted relationship with others were referred to as, "interpersonal". Young adults exhibit disease-specific outcomes such as hyperventilation, chest tightness, breathlessness, exacerbations, and coughing. These outcomes are not unique to this demographic but are symptoms of asthma experienced by individuals with asthma.[203]

Young adults also experienced outcomes that were categorized as interpersonal, such as stigma, exclusion from activities, family separation, and judgements from people. Outcomes classified as personal were limiting in nature and include an inability to perform household chores, an inability to take part in hobbies, and an inability to practice exercise routines.[23] Other personal outcomes include changing jobs due to asthma, slowing down at work, feeling uncomfortable because of asthma, expressing anger towards asthma, feeling anger towards stigmatization from people, feeling different, feeling unsafe, and feeling fear in joining preferred career.

A previous review of the experience of living with asthma across all age groups indicated that individuals with asthma are, in general, also concerned about judgement from others because of asthma or taking medications.[206] For young adults, this concern is important because young adulthood is an age of identity exploration and identity development.[20] Due to fear of judgement, young adults are willing to skip their medication in order to feel "cool" among their peers.[23] On the other hand, other age groups are mainly concerned of judgement in terms of being seen as a burden by society.[206] Young adults with asthma also exhibit positive outcomes such as feeling confidence, feeling free of asthma, and having a lack of anger towards asthma. The positive outcomes reported by the studies included in this review were limited. Having a lack of anger towards asthma comes with accepting the disease and is not unique to young adults alone.[206]

5.2 Aim 2

Effect of Framing on Beliefs: Our study found no relative advantage of gain- versus loss-framed messages on participants' beliefs about their Inhaled Corticosteroid (ICS). Also, there was no significant difference in participants' beliefs at the end of the study compared to baseline. While all participants completed the study, the study was not well powered and may have found different conclusions if we had more participants. Although no published study has assessed the effects of framing on individuals' beliefs about ICS, studies have reported on beliefs pertaining to other health behaviors. A study investigating the effects of framing on vaccination uptake found that perceived benefits were higher in the gain-frame and loss-frame groups compared to control.[80] This study had a sample size of 739 young adult women. Also, in a study promoting testicular examination (n = 128), loss-framed messages produced greater perceived susceptibility to the disease compared to those receiving gain-framed messages.[73] This is expected because testicular examination is a disease detection behavior. According to the Health Belief Model,

greater susceptibility to testicular cancer should lead to a greater performance of testicular examination.[53] In disease detection behaviors, there is a risk of uncovering an unfavorable condition.[87] Therefore, emphasizing the loss of not performing an advocated behavior is more persuasive because people are more risk-seeking when considering risks.[207]

For preventive behaviors, the gain frame is expected to be more persuasive because people are risk-averse when considering gains therefore focusing on gains instead of loss is more persuasive.[87] For example, in a study conducted by Rivers and colleagues, the effectiveness of framed messages in persuading women to obtain a pap smear test was contingent on how the behavior was framed.[69] If the pap smear test was framed as a prevention behavior, gain-framed messages were more effective. If the pap smear test was framed as a detection behavior, then loss-framed messages were more effective. Despite the significant results obtained by these previous studies on the effectiveness of gain-framed messages in promoting positive beliefs, a recent meta-analysis had findings consistent with our study. They found no significant effects of framing on attitudinal beliefs among studies that examined a prevention behavior.[16]

In this study, participants were asked to acknowledge receipt of each message as a proxy to track participant engagement. A participant mentioned at the end of the study that he did not agree with some of the messages and would have loved an opportunity to express his opinion. Therefore, assessing participants level of agreement with framed messages may have provided insight on whether this variable served as a moderator of framing on beliefs. In fact, Rothman and Salovey suggests that acceptance of a message by a participant is crucial in the effectiveness of framing.[82] Future studies may assess this. In the present study, there was no effect of framing on participants' beliefs about their ICS. Of note, participants' agreement with the messages was not assessed in this study.

Effect of Framing on Intentions: In this study, participants had very high intentions to take their medications as prescribed at baseline and at the end of the study. Our initial analysis did not find a significant difference in intentions between participants receiving gain- or loss-framed messages. We also did not find a significant difference in baseline across both groups at the end of study. After controlling for type of non-adherence, framing had significant effects on participants' intentions to take medications as prescribed. Irrespective of whether participants received gain- or loss-framed messages, their intentions increased from baseline significantly. It is possible that the presence of people who had intentional nonadherence and those who had unintentional nonadherence in the same sample served as a confounder in our initial analyses.

There is mixed evidence on the effects of framed messages on illness prevention behaviors. According to Abhyankar et al, loss-framed messages were more effective in increasing intentions to obtain Mumps, Measles, and Rubella vaccine.[77] Meanwhile, Detweiler et al, found that gain-framed messages were more effective in promoting intentions in another disease prevention behavior (utilization of sunscreens).[72] A recent meta-analysis of the effects of framed messages on illness preventive behaviors did not find a significant effect of framing on intentions.[16] This is consistent with our finding prior to controlling for type of nonadherence. Therefore, we speculate that the presence of unknown confounders, such as type of nonadherence in the case of medication adherence, could explain why framing advantage may not have been detected in other illness-prevention studies.

Effect of Framing on Medication Adherence: Health behaviors have been categorized as either preventive or detective behaviors. Detective behaviors have a risk of identifying unfavorable findings and therefore, loss-framed messages may be more persuasive.[82] Prospect Theory provides a plausible explanation, which suggests that when considering loss, individuals are

more risk-taking and when considering gains, individuals are risk-averse.[34] Therefore, in the context of the gains available through illness prevention behaviors, emphasizing gains are more advantageous.

In our study, we considered adherence to inhaled corticosteroid a preventive behavior because the goal of the medication is to prevent asthma exacerbations and ensure asthma control. Therefore, based on the recommendation of Rothman et al and findings from a review conducted by Gallagher et al,[16,82] we hypothesized that gain-framed messages would be more persuasive in encouraging young adults to take their ICS as prescribed. In the present study, there was no gain frame advantage. Although, there was a slight improvement in adherence overtime, regardless of message frame, it was not significant. This study was not well powered. Also, the acceptability of the framed messages to members of the target population was not assessed. A future study should conduct this investigation using an adequate sample size.

Studies investigating the differential effects of gain- versus loss-framed messages have been conducted to promote a range of illness-prevention behaviors including exercise adherence and smoking cessation. In a study promoting exercise adherence among patients entering a cardiac rehab program, gain frame messages resulted in greater exercise participation compared to control.[79] Although exercise adherence was higher in the gain-frame group compared to the loss-frame group, the difference was not statistically significant. Also, in a study promoting smoking cessation, a preventive behavior, a higher proportion of abstainers were found among those in the gain-frame message condition compared to the loss-framed condition.[74] Furthermore, a recent meta-analysis of the effects of health message framing on behavior found that gain-framed messages promoting illness prevention behaviors were more persuasive

compared to loss-framed messages.[16] No published study have assessed the relative advantage of gain- versus loss-framed messages on adherence to medications.

Effect of Framing on Asthma Control: We did not find an advantage from gain-framing over loss-framing in improving asthma control among participants in the study. The reason behind this finding is not clear. However, we found that irrespective of the type of framed message received by participants, there was a significant improvement in asthma control at the end of the study compared to baseline. No published study has investigated the effects of framing on asthma control. We expected an increase in medication adherence to lead to improvement in asthma control. Albeit not significant, we did observe an increase in medication adherence. It is possible that the non-significance was as a result of the fact that the study was not well powered. Furthermore, it is possible that the little improvement in medication adherence was sufficient to lead to improved asthma control among the present sample.

5.3 Aim 3

Guided by the Theory of Planned Behavior, it was hypothesized that: 1) framing will have a direct positive relationship with Beliefs and Intentions, 2) Beliefs will mediate the effects of framing on Intentions, 3) Belief will have a direct positive relationship with Intentions, 4) Intentions will mediate the effects of Beliefs on Adherence, and that 5) Adherence will have a direct positive relationship with Asthma control. Of these hypothesized relationships, two were supported by the study results.

The first hypothesis (4b) that was supported states, "Beliefs will have a direct positive relationship on Intentions". When young adults' perceived necessity of ICS dominates their concerns about ICS, then they have a greater intention to take their ICS as prescribed. The direct

effect of Beliefs on Intentions is consistent with the Theory of Planned Behavior which theorizes that attitudinal beliefs informs' intentions to perform a behavior.[47] Our finding is consistent with an existing study in which attitudinal beliefs also had a significant positive relationship with intentions.[80] In this study the effects of Beliefs on Intentions increased at the end of the study compared to baseline. This suggests an effect of the intervention on that relationship.

The second hypothesis (Hypothesis 5) that was supported states, "Intentions will mediate the effects of Beliefs on Medication Adherence". This finding suggests that greater intentions to take medications as prescribed leads to greater medication-taking behavior. Intentions has significantly predicted adherence to different medications including immunosuppressant therapy, and antihypertensive medications.[167,208,209] A similar study investigating the relationship between framing and constructs of the Theory of Planned Behavior also found a significant positive relationship between Intentions and Behavior (vaccine uptake) with Intentions mediating the effects of Beliefs on the Behavior. In this study, the path from Intentions to Adherence decreased at the end of the study compared to baseline. We speculate that over time, individuals' belief about the necessity of their ICS are more influential in informing their medication-taking behavior compared to intentions.

We hypothesized that framing would have a direct positive relationship with Beliefs (Hypothesis 1). Although a direct positive relationship was observed between framing and Beliefs, it was not significant. A similar study exploring the relationship between framing and constructs of The Theory of Planned Behavior (Beliefs, Intentions, and Behavior) in relation to the uptake of HPV vaccine found a significant relationship between framing and beliefs.[80] This study randomized 739 young adults to watch either gain-framed, loss-framed, or neutral videos (control) about the consequences of receiving HPV vaccine. In this study, gain-framed videos

compared to control had a stronger direct relationship with beliefs (0.15) compared to loss-framed videos versus control (0.12). Therefore, it is possible that this relationship could have been significant in our study if the study was well powered. The improved standardized parameter weights representing the paths from Beliefs to Intentions and Beliefs to Adherence at the end of the study compared to baseline suggests that the intervention may have been influential. Albeit, its not clear if it is the framing effect since its impact was not significant.

We did not find a significant relationship between Adherence and Asthma Control in this study (Hypothesis 6). We reported earlier that Asthma Control improved from baseline in the framing intervention, yet, there was no significant relationship between Adherence and Asthma Control in the path analysis. We speculate that a small sample size may be responsible for the failure to detect a significant relationship. Given that medication adherence is multidimensional, we also speculate that we may not have captured the dimension of adherence that directly relates with asthma control. In the framing intervention, we did observe a non-statistically significant increase in Adherence from baseline. It is possible that the ACT was very sensitive to those changes in Adherence, hence, the improved Asthma Control. Although the Theory of Planned Behavior does not have a direct link between attitudinal belief and behavior, we found that Beliefs had a direct positive relationship with Adherence.

Our findings of a direct positive relationship between Beliefs (BMQ necessity-concerns differential) and Adherence suggests that young adults are more Adherent to their ICS if the Perceived Necessity of the medication is stronger than the Perceived Concerns about the medication. This is consistent with the findings of a previous study which examined the relationship between participants Beliefs (defined as used in this study) about ICS and Adherence.[210] The previous study found a significant positive correlation between Beliefs and

Adherence measured via self-reported and pharmacy records. We speculate that interventions that promote the perceived necessity of young adults about ICS will impact their intentions to be adherent as well as their actual medication-taking behavior. The direct positive relationship between Beliefs and Adherence suggests that contrary to the relationship suggested by the Theory of Planned Behavior, Intentions do not fully mediate the effects of Beliefs on Behavior. Interestingly, the relationship between Beliefs and Adherence becomes stronger at the end of the study compared to baseline. Although this suggests a possible effect of framing, the failure to find a significant effect of framing on Beliefs limits our capability to make that assertion.

Although we predicted that framing would have a direct positive effect on intentions, this hypothesis (Hypothesis 3) was not supported. It is possible that the effects of framing on Intentions are completely mediated by Beliefs. A similar study promoting the uptake of vaccines found a complete mediation of the effects of framing on Intentions by Beliefs.[80] No published study has investigated the relationship between framing and Intentions to take ICS among young adults.

5.4 Strengths

The review utilized a comprehensive search strategy to ensure that all published articles addressing the research question were included. Also, it followed the systematic process described in the Preferred Reporting Items for Systematic reviews and Meta-Analyses.[171] This ensures rigor and replicability in research because of the systematic process in which studies were identified, selected and included in the study. Furthermore, a grounded theory approach was used in the review to ensure that our findings of what it means to live with asthma as a young adult were grounded in the data obtained from included studies. The included studies were

high quality studies with the minimum score being 75%. An additional strength was that reviewers had a good agreement in the coding of included studies (Krippendorf's alpha = 0.71).

In the development of messages for the framing intervention, rounds of feedback from an expert in message framing as well as an individual with asthma strengthened the study. We consider the study design of the framing intervention a strength because it makes causal inference possible. Although we used self-report, all scales apart from the Intentions scale were previously confirmed to be valid and reliable. The Intentions scale had a good reliability in this study (Cronbach's Alpha = 0.886). Another major strength of this study was a 100% retention of all participants that enrolled for the study. Also, all participants contributed data at the baseline, month 1, as well as the end of the study at month 2. Participants' engagement with the text messaging interventions was 85.9%, as assessed by their response to each text message received during the intervention. Furthermore, a total of 1,032 text messages were successfully delivered to participants. There were no errors or failure in message delivery reported by participants, indicating a 100% transmission rate.

This study contributes significant findings about the relationship between framing, Beliefs, Intentions, Medication Adherence, and Asthma control. We found that there is a direct, positive relationship between Beliefs and Intentions. Also, we found that although Intentions mediates the effects of Beliefs on Medication Adherence, the mediation is partial due to the direct relationship between Beliefs and Medication Adherence. Additionally, the effects of Beliefs on Intentions and Medication Adherence increased from baseline at the end of the study. Therefore, we consider the path analysis conducted in this study a strength. Furthermore, the findings of this study are important given that Beliefs has never been investigated as a possible mediator of the effects of framing on Intentions to take ICS.

5.5 Limitations

A limitation of the review conducted in Aim 1 is the small number of included studies reflecting a paucity of qualitative research focusing on young adults living with asthma. This is expected given that the concept of young adulthood is still new with limited studies addressing the needs of this demographic. Another potential limitation is that the second reviewer only coded 20 percent of the qualitative data. However, coding as little as 10 percent is considered an acceptable practice in the analysis of qualitative data.[211] The included studies were performed in Australia (n =40), Denmark (n = 10), United Kingdom (n = 21), and the United States (n = 53). Therefore, findings may not generalize to young adults from other parts of the world.

We did not elicit feedback from young adults with asthma on the messages used for the framing intervention. While we consider this a limitation, feedback from the target population is not typically obtained in framing interventions.

For Aim 2, the sample size of the framing intervention was small, which did not provide adequate power to test some of the hypotheses. Also, our sample was focused on young adults with asthma enrolled in college and may not generalize to other young adults that may not be attending college. We also relied on self-report in this study to measure participants Beliefs, Intentions, Adherence, and Asthma Control. Self-report is subject to social desirability bias and we found the presence of a moderate amount of social desirability in our study. However, it only correlated significantly with two measures – concerns about medication measured at the end of the study, and Asthma Control measured at the midpoint of the study (week four). Self-report is also vulnerable to recall bias. It is possible that using more objective measures may have yielded a different result. Another limitation in the framing interventions is that a diagnosis of asthma as

well as possession of an ICS was by self-report. There was no way to confirm their self-report other than asking the name of the ICS that they were on. Furthermore, data from the texting platform suggests over 85% participant engagement. However, there is no way to ascertain that participants were the ones acknowledging the receipt of messages. A recent meta-analysis found text message reminders to be effective in promoting adherence to ICS.[63] In the current study, the paths from Framing to Beliefs and Framing to Intentions were not significant. Therefore, our overall findings of improvement in Intentions and Asthma Control may have been due to texting rather than framing.

For Aim 3, the study sample size was a primary limitation of the path analysis. Typically, 10 cases per variable is utilized in path analysis, which would have required at least 50 participants. Our study included 43 participants.

Finally, the seasonal variation in asthma was not accounted for in this study. There is evidence that asthma symptoms peak for young adults in the US in September through November, which happens to be the period within which this study was conducted. Therefore, it is possible that our findings may have been different if the study were conducted at a different time of the year.

5.6 Implications and Conclusions

In our study, the sample size was inadequate to establish the differential effects of framing on Beliefs, Intentions, Medication Adherence, and Asthma control. A future study should utilize a larger sample size to provide adequate power to detect the differential effect of gain- versus loss-framed messages. Furthermore, we did not obtain the opinion of young adults on the framed messages prior to use. A future study should obtain participants agreement or

disagreement with the messages and examine how that impacts participants Beliefs, Intentions, Medication Adherence, and Asthma control. The effects of framed messages on the medication adherence of other patient population as well as other types of conditions deserves an additional study.

Young adults are more likely to exhibit positive behaviors with desirable outcomes such as confidence in disease management when their needs are met, adequate enablers are present, and barriers such as accepting the chronic nature of asthma have been removed. In this study, framed mobile messages delivered via SMS improved young adults' intentions to take their medication as prescribed as well as their asthma control. Further studies with a control group are needed to support causality. A 100% retention rate and over 85% engagement rate suggests that young adults are comfortable receiving text messages promoting adherence to ICS. Beliefs about the necessity of ICS may lead to greater intentions to take the medications as well as consistent medication-taking behavior.

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Appendix 1: Search Strategy

#	Concept	Terms
1	Asthma	"asthma"[mesh] OR asthma[tiab]
2	Impact/Outcome	"Outcome Assessment (Health Care)"[Mesh] OR "Population Health"[Mesh] OR "Outcome and Process Assessment (Health Care)"[Mesh] OR outcome[tiab] OR "Quality of Life"[Mesh] OR HRQOL[tiab] OR (quality [tiab] AND life[tiab])
3	Qualitative research	"Qualitative Research"[Mesh] OR "Focus Groups"[Mesh] OR "qualitative"[tiab] OR "Focus group"[tiab] OR "Interview"[tiab] OR phenomenology[tiab] OR "thematic analysis"[tiab] OR "grounded theory"[tiab]
4	Young adults	student[Tiab] OR "students"[mesh] OR "young adult"[mesh] OR "adolescent"[mesh] OR adolescent[Tiab] OR adolescence[Tiab] OR youth[tiab] OR teen[tiab] OR ((young[tiab] OR emerging[tiab]) AND adult[tiab])
5	Search Strategy	1 AND 2 AND 3 AND 4

Appendix 2: Article Quality Assessment

Article	MMAT Design Category[a]	Quality Criteria[a]			Quality Score[a]
		Criteria	**Criteria Met**	**Comments**	
[22]Cole S, et al. 2013	Qualitative	Sources of qualitative data are relevant	Yes		75%
		Process of analyzing qualitative data is relevant	Yes		
		Appropriate consideration given to how findings relate to context	Yes		
		Appropriate consideration given to how findings relate to the researchers' influence	No		
[188]Coombs N, et al. 2018	Mixed Methods (Qualitative plus quantitative descriptive)	Sampling strategy is relevant to address the quantitative research question	No		75%
		Sample is representative of the population understudy	Yes		
		Measurements are appropriate (clear origin, or validity known, or standard instrument)	Yes		
		There is an acceptable response rate (60% or above)	Yes		
		Sources of qualitative data are relevant	Yes		
		Process of analyzing qualitative data is relevant	Yes		
		Appropriate consideration given to how findings relate to context	Yes		
		Appropriate consideration given to how findings relate to the researchers' influence	Yes		
		Mixed method design relevant to the questions	Yes		
		Integration of qualitative and quantitative data is relevant	Yes		
		Appropriate consideration given to the limitations of this integration	Yes		
[186]Davis SR, et al. 2018	Mixed Methods (Qualitative plus quantitative descriptive)	Sampling strategy is relevant to address the quantitative research question	No	Sample size for the quantitative aspect of the study not justified	75%
		Sample is representative of the population understudy	Yes		
		Measurements are appropriate (clear origin, or validity known, or standard instrument)	Yes		
		There is an acceptable response rate (60% or above)	Yes		
		Sources of qualitative data are relevant	Yes		
		Process of analyzing qualitative data is relevant	Yes		
		Appropriate consideration given to how findings relate to context	Yes		
		Appropriate consideration given to how findings relate to the researchers' influence	Unable to determine	Not specified	
		Mixed method design relevant to the questions	Yes		
		Integration of qualitative and quantitative data is relevant	Yes		
		Appropriate consideration given to the limitations of this integration	Unable to determine	Limitations associated with integration not specified	
[189]Druedahl LC, et al. 2018	Qualitative (focus groups and interviews)	Sources of qualitative data are relevant	Yes		100%
		Process of analyzing qualitative data is relevant	Yes		
		Appropriate consideration given to how findings relate to context	Yes		
		Appropriate consideration given to how findings relate to the researchers' influence	Yes		
[13]MacDonell KK, et al. 2015	Qualitative	Sources of qualitative data are relevant	Yes		100%
		Process of analyzing qualitative data is relevant	Yes		
		Appropriate consideration given to how findings relate to context	Yes		

		Appropriate consideration given to how findings relate to the researchers' influence	Yes		
[187]Peters D, et al. 2017	Qualitative	Sources of qualitative data are relevant	Yes		100%
		Process of analyzing qualitative data is relevant	Yes		
		Appropriate consideration given to how findings relate to context	Yes		
		Appropriate consideration given to how findings relate to the researchers' influence	Yes		
[23]Speck LA, et al. 2014	Qualitative	Sources of qualitative data are relevant	Yes		100%
		Process of analyzing qualitative data is relevant	Yes		
		Appropriate consideration given to how findings relate to context	Yes		
		Appropriate consideration given to how findings relate to the researchers' influence	Yes		

[a]Quality assessed using the Mixed Methods Appraisal Tool (MMAT) – Version 2011. MMAT contains 5 study design categories: qualitative, quantitative randomized controlled, quantitative non-randomized, quantitative descriptive, and mixed methods. Each category contains 4 (or 3 for Mixed Methods) criteria. Scores range from 0% to 100%. For qualitative, quantitative randomized controlled, quantitative non-randomized, and quantitative descriptive studies, scores are calculated as a percentage of criteria met. For mixed methods studies, scores are calculated as the lowest score from among the 3 relevant designs (quantitative [Quan], qualitative [Qual], mixed methods [MM]): 25% when Quan=1 or Qual=1 or MM=0; 50% when Quan=2 or Qual=2 or MM=1; 75% when Quan=3 or Qual=3 or MM=2; 100% when Quan=4 or Qual=4 or MM=3.

Appendix 3: Transcript for Telephone Recruitment

(The primary investigator communicated with participants with the transcript below)

Hello, are you calling about the asthma research study?

Thank you for calling,

1. Are you between 18 – 29 years old?

2. Have you been prescribed a daily inhaled medication for asthma?

3. Do you remember the name? [This question was asked to help verify that the student is taking an inhaled corticosteroid].

4. Are you a student at Auburn University?

5. Can you send and receive text messages with your phone?

Thank you.

If student is not eligible based on the above questions, "thank you for your time, unfortunately you are not eligible to participate in this study".

If eligible, would you be willing to hear more information about this study?

(If yes, continue with below. If no, thank them for their time and end the call.)

Thank you for agreeing to continue. Let me tell you more about this study and what will be required of you.

Your participation is completely voluntary. This means that you do not have to participate in this study unless you want to. Your decision whether or not to participate in this study will not affect your relationship with Auburn University, or the Harrison School of Pharmacy.

The purpose of this study is to learn more about asthma among college students.

If you decide to participate in this research study, you will be sent text messages three times a week for eight weeks and may be asked to reply to the messages. You will also be asked to take part in three surveys administered at the beginning of the study, four weeks, and eight weeks afterwards.

The surveys will be accessed via a link sent to your email or phone.

Questions will include information about you such as your age, race, and ethnicity. Other questions will also be asked regarding your asthma medication use, beliefs about medications, and asthma control.

Upon completion of the first survey, you will receive a $10 Amazon gift card.

The second survey will take place four weeks after the study begins. Upon completing the second survey, you will be entered into a drawing for a chance to receive one of ten $10 Amazon gift cards. The chance of being drawn is approximately one out of ten.

The third survey will be administered at the end of the study. Upon completion of the third survey, you will be given a $15 Amazon gift card.

If you decide to participate, you may be charged normal rates for sending and receiving text messages if your carrier charges for sending and receiving text messages. Also, there will be normal Internet charges for completing the surveys online.

Do you have any questions at this time?

Would you be willing to consider participation in this research?

If 'no', caller will be thanked for their time and the call ended.

If 'yes', then below.

Thank you.

Please can you give me your auburn email address?

Caller: [provides email address]

Thanks, please can you give me phone number?

Caller: [provides phone number]

Thank you, can you send and receive text messages with this?

Caller: Yes/No (If no, please can you provide a number that you send and receive text messages with?]

Thank you

Please choose a code consisting of four numbers? This is your participation code. We will request you to input this code in all the surveys. Please use a code that is easy to remember.

Caller: [provides code]

We will send you a link to a survey via your phone and email for all surveys. Use either means to complete the survey. You can expect the first survey within one week after this conversation. Please complete the survey as soon as possible. The first page on the survey is an informed consent. Please read it carefully and respond. After completing the first survey, you will receive a $10 Amazon gift card.

Do you have any questions?

Thank you for your time.

Appendix 4: Beliefs about Medicines Questionnaire – Specific[180]

Rated from strongly disagree (1) to strongly agree (5)

1. My health at present, depends on my medicines (necessity)

2. Having to take medicines worry me (concerns)

3. My life would be impossible without my medicines (necessity)

4. Without my medicines, I will be very ill (necessity)

5. I sometimes worry about the long-term consequences of my medicines (concerns)

6. My medicines are a mystery to me (concerns)

7. My health in the future will depend on my medicines (necessity)

8. My medicines disrupt my life (concerns)

9. I sometimes worry about becoming too dependent on my medicines (concerns)

10. My medicines protect me from getting worse (necessity)

Appendix 5: The Asthma Control Test[33]

1. In the past 4 weeks, how much of the time did your asthma keep you from getting as much done at work, school, or at home?					Score
All of the time [1]	Most of the time [2]	Some of the time [3]	A little of the time [4]	None of the time [5]	------------
2. During the past 4 weeks, how often have you had shortness of breath?					
More than once a day [1]	Once a day [2]	3 to 6 times a week [3]	Once or twice a week [4]	Not at all [5]	------------
3. During the past 4 weeks, how often did your asthma symptoms (wheezing, coughing, shortness of breath, chest tightness, or pain) wake you up at night or earlier than usual in the morning?					
4 or more nights a week [1]	2 or 3 nights a week [2]	Once a week [3]	Once or twice [4]	Not at all [5]	------------
4. During the past 4 weeks, how often have you used your rescue inhaler or nebulizer medication (such as albuterol)?					
3 or more times per day [1]	1 or 2 times per day [2]	2 or 3 times per week [3]	Once a week or less [4]	Not at all [5]	------------
5. How would you rate your asthma control during the past 4 weeks?					
Not at all controlled [1]	Poorly controlled [2]	Somewhat controlled [3]	Well controlled [4]	Completely controlled [5]	------------
If your score is 19 or less, your asthma may not be as well controlled as it could be. **No matter what your score is, share your result with your healthcare provider.**				**Total**	--------------

Appendix 6: Medication Adherence Report Scale for Asthma[31]

How often do you do the following?

Answers: (1) Always (2) Often (3) Sometimes (4) Rarely (5) Never
1. I only use my medication when I need it
2. I only use it when I feel breathless
3. I decide to miss out a dose
4. I try to avoid using it
5. I forget to take it
6. I alter the dose
7. I stop taking for a while
8. I use it as a reserve, if my other treatment does not work
9. I use it before doing something which might make me breathless
10. I take it less than instructed

Appendix 7: Short Version of the Marlowe-Crowne Social Desirability Bias Scale[183]

#	Items
1	I'm always willing to admit it when I make a mistake
2	I always try to practice what I preach
3	I never resent being asked to return a favor
4	I have never been irked when people expressed ideas that are very different from my own
5	I have never deliberately said something that hurt peoples' feelings
6	I like to gossip at times
7	There have been occasions when I took advantage of someone
8	I sometimes try to get even rather than forgive and forget
9	At times, I have insisted on having things my own way
10	There have been times when I felt like smashing things

Scoring Key

1. T	4. T	7. F	10. F
2. T	5. T	8. F	
3. T	6. F	9. F	

Matching answers receive one point. After assigning points, the scores are then summed.
Scores range from 0 to 10 (no social desirability to high social desirability).