How Do People Feel While Walking? A Multivariate Analysis of Emotional Well-Being for Utilitarian and Recreational Walking Episodes

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Abstract
Walking is a mode of transport that offers many benefits. This study aims to provide insights on the emotions associated with different types of walking episodes – namely, utilitarian walking episodes that are undertaken with the purpose of fulfilling an activity at a destination and recreational walking episodes that are undertaken with no specific purpose/destination. A knowledge of the emotions associated with different types of walking episodes can help steer policies and investments in a way that would engender greater levels of walking. The paper utilizes the well-being module of the American Time Use Survey (ATUS) data set to model subjective ratings on five different emotions associated with walking, employing a total of 1583 walk episodes. The five emotions include happiness, meaningfulness, tiredness, stress, and painfulness. A multivariate ordered probit model is estimated to account for unobserved attributes that may simultaneously affect multiple emotions. Model estimation results show that a number of socio-demographic variables and walking episode attributes affect how people feel about recreational and utilitarian walking episodes. Overall, it is found that utilitarian walking episodes offer a lower level of positive emotions than recreational episodes – presumably because recreational episodes are undertaken in more pleasant environments under more relaxing conditions. The results suggest that investments in recreational walking infrastructure and green spaces may yield richer dividends in terms of engendering higher levels of walking. Targeting specific socio-demographic groups for awareness campaigns and having strategic parking policies based on the day of the week are some of the other important implications.

Keywords: time use, utilitarian walking, recreational walking, well-being, ordered probit, multivariate analysis

1. INTRODUCTION

The most common and natural form of physical activity is *walking*. Walking is readily repeatable, can be habit-forming, and is the foremost instrument for increasing physical activity in sedentary populations (Morris and Hardman, 1997). The health benefits of walking are well documented. Major health benefits of walking include reduction in obesity and risk of excess weight (*e.g.*, Smith et al., 2008; Hanson and Jones, 2015, Frank et al., 2007, Bassett et al., 2008), lower cholesterol and triglycerides level (Hu et al., 2001, Hanson and Jones, 2015), lower rate of cardiovascular disease related mortality (Gregg et al., 2003, Morgan et al., 2010, Lee and Buchner, 2008), blood pressure control (Hayashi et al., 1999, Hanson and Jones, 2015), reduction in total and ischemic strokes particularly in women (Hu et al., 2000) and reduction in mortality (Gregg et al., 2003). Walking also enhances emotional and mental health. Studies have related walking to reduction in anxiety, depression, anger and time-pressure, and an increase in revitalization, positive engagement and tranquility (*e.g.*, Ekkekakis et al., 2008, Johansson et al., 2011, Robertson et al., 2012).

A walking episode may be classified under one of two categories based on the purpose of the activity at the destination (if there is a destination) – *utilitarian* or *recreational* (see for example, Sallis, 2004, Copperman and Bhat, 2007, Kang et al., 2017, Procter-Gray et al., 2015, Doescher et al., 2017). Utilitarian walking refers to walking episodes (trips) that are undertaken to fulfill specific purposes or tasks outside the home at a destination. This includes walking to work, grocery stores, non-grocery activity locations, social visits, eating-places, and movies or other recreational places. On the other hand, recreational walking is primarily undertaken as a leisure activity without any specific purpose or destination, such as walking around the block/neighborhood or walking in a park. Traditionally, utilitarian walking has been the focus of transportation and urban planners (who investigate the use of walk as a mode of transport to reach destinations), while recreational walking has been extensively studied by public health professionals (see Hekler et al., 2012 and Mirzaei et al., 2018).

Although prior research has amply documented determinants and health/environmental consequences of walking, (both utilitarian and recreational), there has been relatively little research on how people feel about walking episodes (trips) from an emotional standpoint. Studying how people feel about walking episodes is important for a number of reasons. First, how a person feels during a walking episode would likely influence the propensity to participate in a similar walking episode in the future. This notion of having a tendency to reselect travel modes that provide satisfying experience was recently studied by De Vos et al. (2019) in the context of walking and cycling. In other words, if an individual feels positive about a particular walking episode, then he or she would potentially be inclined to undertake similar walking episodes in the future. Walking is a repeatable activity; however, individuals are unlikely to repeat the activity and make a habit of walking unless the walking episodes engender positive emotions. In other words, the propensity to walk for utilitarian or recreational purposes may not only depend on built environment attributes and socio-economic and demographic characteristics, but also on how people feel about walking episodes. These feelings may accumulate over time, and the accumulated experience is likely to impact the extent to which people continue to engage in walking. Determining the factors that contribute to a positive walking experience would therefore help policymakers devise strategies and interventions that enhance the walking experience.

Second, in spite of the rising awareness regarding the benefits of physical activity and the health hazards of leading a physically inactive life, only one in three adults in the U.S. meet the weekly requirements of physical activity (National Center for Health Statistics, 2012) and obesity is on the upsurge. This might point to the fact that people do not substantially comprehend the importance of walking for health since the outcomes related to good health are not immediately realized, i.e. walking for good health is a relatively long-term process and is generally observed after persistent maintenance of regular physical activity or walking. Under such a scenario, what might be of greater interest is how people feel emotionally while walking because the emotional feelings while performing the activity is what can be directly observed or reported. Therefore, feelings pertaining to walk episodes can prove to be potent in directing decision-makers to instrument investments for the betterment of the individuals' walking experiences based on the immediate emotions of people.

Third, the emotions associated with a walking episode may not necessarily be directly inferred from the type of walking episode (utilitarian versus recreational). In a rather straightforward interpretation, a recreational walking episode may be viewed as being more positive and pleasant than a utilitarian walking episode. However, that may not necessarily hold true. A recreational walking episode may require dedicating separate time for the activity - as discretionary/available time is often a scarce resource, the recreational walking episode may actually engender feelings of stress (and negative emotions). On the other hand, a utilitarian walking episode that is an integral part of the daily activity agenda (*e.g.*, walk to work or walk to store) may be viewed more positively as it provides a perception of not placing additional time pressure (stress) on the individual *and* also provides health benefits.[1] The complex nature of the relationship between emotions and activity engagement in the context of evolving lifestyles calls for a detailed analysis of emotions associated with different types of walking episodes.

Finally, an understanding of the emotions engendered by different types of walking episodes would also be of value to policy makers and planners. Planners design urban spaces and infrastructure elements to enhance quality of life. Through an understanding of the determinants of emotions (which serve as measures of well-being), planners will be able to pursue investments that truly contribute to enhancing quality of life. If walking infrastructure and urban spaces are designed in a way that promotes walking episodes associated with positive emotions, then an increase in walking activity may occur – yielding health and environmental benefits that would not have been realized otherwise. If the positive emotions are greater for utilitarian walking episodes, then it would behoove planners and policy makers to invest in (a network of) wide and shaded sidewalks that are separated from fast moving traffic. On the other hand, if emotional feelings are more positive for recreational walking episodes, then the community may be better served by investments in green spaces, recreational areas and parks, and walking trails/paths in natural environments (as opposed to built environments).

The analysis of emotions associated with walking episodes is accomplished in this paper using the well-being module of the American Time Use Survey (ATUS) data set. The well-being module of the ATUS had respondents rate their feelings of emotions along six emotional dimensions – happiness, sadness, meaningfulness, painfulness, stressfulness, and tiredness – for a random set of activities that they pursued on the day for which they reported time use data. Walking

[1] In fact, it was a personal experience along these lines that led to the research in this paper. When a visiting professor in Hong Kong, the corresponding author found himself preferring to take a hotel shuttle that serviced an area near to his workplace and then walking about 25 minutes to work, rather than taking a more direct subway system that entailed little walking and a lower total travel time by about 15 minutes. But the two 25 minute walk episodes (to and fro from work) served, in the perception of the corresponding author, as the exercise episodes of the day and relieved the need to allocate separate time to pursue aerobic exercises at the beginning or end of the day.

activities are extracted from this database to model the emotions associated with utilitarian and recreational walking episodes.

The remainder of this paper is organized as follows. The next section provides a review of some concepts based on prior research, while the third section describes the data used in this study. This is followed by a description of the modeling methodology adopted for modeling the emotions related to walking. The fifth section presents model estimation results and policy implications. Concluding remarks are offered in the sixth and final section.

2 RECREATIONAL/UTILITARIAN WALKING AND EMOTIONAL FEELINGS

Transportation and urban planning professionals have generally strived to quantify the influence of various socio-economic, demographic, and built environment factors on the propensity to choose walk as a mode of transportation to fulfill activities outside the home. By doing so, planners can promote the choice of walking as a transportation mode by nudging several environmental factors and targeting specific socio-demographic groups for interventions and awareness campaigns. A number of past studies have focused on capturing the socio-demographic variations in utilitarian walking and determining attributes of the built environment that are correlated with higher amounts of walking (*e.g.*, Rajamani et al., 2003, Cerin et al., 2007, Cervero et al., 2009, Norman et al., 2013, Knuiman et al., 2014, Park et al., 2015, Ambrey and Bitzois, 2018, Park and Garcia, 2019). On the other hand, past research in the physical activity, psychology and public health domains have primarily focused on walking for recreational purposes with a view to promote exercise, fitness, and healthy lifestyles. These studies attempt to relate demographic variables to health indicators or the prevalence of diseases and then isolate and quantify the influence of recreational walking or total walking on health and disease (*e.g.*, Ekkekakis et al., 2008, Williams et al., 2008, Sallis et al., 2019, Gavand et al., 2019). These studies also focus on the environmental correlates that promote recreational walking and health (*e.g.*, Gomes et al., 2011, Hekler et al., 2012, Adachi-Mejia et al., 2017).

The differences in the propensity to engage in utilitarian and recreational walking based on built environment factors as well as socio-demographic groupings suggest that the two forms of walking should be analyzed separately. Moreover, there may be substitution effects between the amount of utilitarian and recreational walking undertaken by individuals, an issue explicitly raised by and investigated in Copperman and Bhat, 2007. For example, when faced with daily time constraints, health-conscious individuals may consciously undertake utilitarian walking instead of allocating separate time for recreational (health-related) walking. Similarly, longer bouts of recreational walking for exercise may be replaced by shorter bouts of utilitarian walks coupled with intense physical activity in a fitness facility. Such substitution effects could impact the spatial distribution of walk trips and present challenges in identifying the built environment attributes that need to be targeted for intervention and improvement.

Given that both utilitarian and recreational walking can enhance health, and that there may be substitution effects between the amounts of utilitarian and recreational walking, there is an increasingly synergistic research agenda between the planning and public health professions (see Saelens and Handy, 2008, Kruger et al., 2008, Sener et al., 2010, Sener et al., 2011, Christian et al., 2011, Doescher et al., 2014, Stewart et al., 2016, Buehler et al., 2020, Özbil et al., 2020). In spite of the resulting large body of research examining the sociodemographic and built environment correlates of the two different types of walking, there remains a paucity of research on the emotions associated with the different types of walking episodes. Emotion is defined most simply as "bioregulatory reactions that aim at promoting, directly or indirectly, the sort of physiological states that secure not just survival but survival regulated into the range that we, conscious and thinking creatures, identify with well-being" (Manstead et al., 2004). The American Time Use Survey (ATUS) well-being module data used in this study has information on six emotions – happiness, meaningfulness, sadness, painfulness, stressfulness, and tiredness. These six emotions are tied closely to momentary episode-specific experienced well-being (ExWB) or affective purely hedonic states as opposed to longer-term evaluative well-being (the ExWB measures "capture emotions as they fluctuate from moment-to-moment and in response to day-to-day events and activities" (see NRC, 2013), while the latter "evaluative well-being" measures refer to longer-term life-evaluation states). Of the six emotions, "meaningfulness" may also be viewed as a eudaimonic well-being measure. A eudaimonic measure is one that can be associated with an ExWB state or an evaluative well-being state and refers to an individual's perception of the purpose or meaningfulness of an activity or a certain life-course. Such measures are "crucial in understanding (or predicting) why and when people engage in various activities during the day or choose various life courses" (NRC, 2013).

The six different emotions -- happiness, meaningfulness, sadness, painfulness, stressfulness and tiredness -- have generally well-defined explanations in the literature. Happiness can be defined as "inner well-being" or "inner harmony" (Fave et al., 2016). This idea is closely related to meaningfulness. Meaningfulness generally refers to the pursuit of perceived valuable goals (Martela, 2017). As discussed earlier, meaningfulness is a eudaimonic well-being measure associated with purpose and self-esteem, and so a high meaningfulness for walking (say because of the conviction that walking is healthy for physical and mental health) can make an individual continue to walk even if a walking episode makes a person feel tired or stressed in a momentary assessment). The remaining four emotions are associated with negative states. Sadness relates to a general emotional feeling of suffering or despair or helplessness, while painfulness stems from the more specific feeling of pain itself, which refers to "unpleasant sensory and emotional experience" (Williams and Craig, 2016). Stressfulness is perceived as a negative emotion; stress generally occurs when a person strives to achieve something which he or she feels is beyond his or her coping resources (Montero-Marin et al., 2014). Tiredness, the sixth emotion, is mostly related to exhaustion caused by excess physical or mental energy expenditure (Stadje et al., 2016). Although the emotions are undoubtedly correlated with one another, a number of studies have emphasized the unique aspects of the different emotions. For example, happiness and meaningfulness both relate to positive emotions; however, there are substantial differences in the realizations of the two emotions. For example, taking a child to a park may not necessarily lead to momentary happiness for the episode (and, in fact, can be viewed as a chore) but yet can be viewed as being meaningful. On the other hand, time spent watching television may lead to momentary happiness, but may not be considered very meaningful (Kahneman and Krueger, 2006). Similarly, earlier research has clearly documented the unique nature of the negative emotions. Indeed, correlations across negative emotions tend to be much lower than those across positive emotions (see, for example, Kapteyn et al., 2015). These results suggest that a multivariate analysis that simultaneously and explicitly considers all emotions, and the correlations among them, would be an appropriate methodological approach to model feelings of emotions associated with walking episodes.

3 DATA AND SAMPLE USED

The data for this study is drawn from the American Time Use Survey (ATUS), which is conducted annually by the Bureau of Labor Statistics (BLS) in the United States since 2003. The ATUS gathers detailed 24-hour time use data for a sample of residents aged 15 years and over. The ATUS data primarily consists of information on activity participation and socio-demographic characteristics of a nationally representative sample. In each of the years of 2010, 2012, and 2013, the survey included a special well-being module in which respondents recorded their subjective emotional ratings for three randomly selected activity episodes. Respondents were asked to rate the intensity of six emotions on a seven-point scale (0 through 6) in which higher ratings indicated a stronger intensity of the emotion. In this study, we exclude the 'sadness' emotion in the analysis of walk episodes and focus only on the remaining five emotions[2].

The data preparation process entailed extracting information on walk-related activity episodes from the three years of ATUS well-being modules. Walking events reported as being undertaken for activities classified under the *recreational* code were designated as recreational walk episodes, while all other walking events (for participating in non-recreational activities) were designated as utilitarian walk episodes. A total of 1638 walk episodes were available for analysis. However, emotional ratings for a few of the observations were found to be missing and were removed from the sample. After data cleaning, the final sample included 1583 walk episodes. In some cases, the same individuals reported the ratings for more than one walk episode; therefore, the final sample of 1583 episodes corresponds to 1326 unique individuals.

Table 1 provides a summary of the descriptive characteristics of the sample. Because the walk episode is the unit of analysis in this paper, the descriptive characteristics are provided at the episode level. However, because the number of episodes and the number of unique individuals are rather similar in value, the distributions presented reflect the distributions of the sample individuals.

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[2] The 'sadness' variate was included in our initial modeling efforts; however, only three exogenous variables ("*Age over 65 years", "Individual self-reports health as good, very good or excellent"*, and "*Social interaction while walking"*) turned out to be significant for this variate at 95% confidence level. Furthermore, all the three variables had the opposite signs compared to the 'happiness' variate, which is quite intuitive. The overall unconditional Pearson correlation between the "sadness" and "happiness" ratings was in the order of -0.6, while the polychoric correlation between the two variates (that is, the correlation in the underlying latent variables for the two variables) was much higher in the order of -0.7. As indicated by Schmukle and Egloff (2009), page 277, emotive state ratings tend to be positively skewed rather than being normal distributions, and multivariate distributions of emotive states are far from being multivariate normally distributed; however, these are the assumptions made in computing the Pearson correlations for the linear association between emotive states. On the other hand, Schmukle and Egloff indicate that the underlying latent variables (and the resulting polychoric correlation) provide a much better representation to assess linearity association. That is also the reason why the modeling framework used in the current paper is based on an underlying latent variable approach. The overall suggestive implication from the high negative polychoric correlation is that the "sadness" and "happiness" emotions are, relatively speaking, polar opposites and do not co-occur much at least in the context of the underlying ExWB propensities associated with walk episodes. The psychological literature does typically differentiate happiness and sadness, because the state of happiness today is relative to the state of sadness in the past. That is, deeper states of sadness in the past can engender a deeper state of happiness in the present or vice-versa, because happiness and sadness are each relative emotions and opponent process theory from physiology suggests that each of us has a baseline state of homeostasis and ups and down are followed by reverses to re-stabilize to that baseline state (see Solomon and Corbit, 1974 and Solomon, 1980). But this positive association between happiness and sadness is likely to be more pertinent when investigating relationships among well-being emotions at <u>different</u> points in time in a <u>longer-term longitudinal</u> fashion than for momentary ExWB measures. Of course, in the context of momentary ExWB measures too, a high association and high co-occurrence of both happiness and sadness is not impossible, though is known to be relatively rare and is typically confined to emotionally complex and intense situations (such as the bitter-sweet moments associated with a graduation when a person may feel sad to leave the past but also be excited/happy about what a person has achieved and is about the explore in the future; or the death of a loved one who has had a good long life, when an individual feels sad to lose a beloved one but may also be happy that the loved one is no more in pain/distress; see Larsen, 2017). In most common (less emotionally complex) activities/events (such as walking episodes), the near mirror inverseness and low co-occurrence of the ExWB states of sadness and happiness is likely to hold (see, for example, Russell and Carroll, 1999, Larsen et al., 2017).

TABLE 1 Descriptive Characteristics of ATUS Sample (N = 1583 Walk Episodes)

Variable	Count	%	Variable	Count	%
Socio-demographic variables					
Age			**Annual Household Income**		
Under 20 years	176	11%	Under $10,000	175	11%
20-35 years	410	26%	$10,000-$19,999	227	14%
36-50 years	404	26%	$20,000-$34,999	276	17%
51-65 years	349	22%	$35,000-$49,999	207	13%
Over 65 years	244	15%	$50,000-$99,999	405	26%
Sex			$100,000 or more	293	19%
Female	806	51%	**Household Size**		
Male	777	49%	1	528	33%
Employment Status			2	353	22%
Employed	859	54%	3	271	17%
Unemployed	724	46%	4	244	16%
Level of Education			5	115	7%
Less than High School	322	20%	6	40	3%
High School	323	20%	7+	32	2%
Associate /Some College	362	23%	**Number of Children in Household**		
Graduate	300	19%	0	952	60%
Post Graduate	276	17%	1	269	17%
White			2	229	14%
Yes	1127	71%	3	97	6%
No	456	29%	4+	36	2%
Hispanic			**Household Structure**		
Yes	282	18%	Single	528	33%
No	1301	82%	Couple	309	20%
Health			Single Parent	111	7%
Good, Very Good, Excellent	869	55%	Nuclear Family	365	23%
Other	714	45%	Joint Family	270	17%
Physiological difficulty in walking			**Daily non-work family time spent**		
Yes	96	6%	At least 4 hours	644	41%
No	1487	94%	Less than 4 hours	939	59%
Walk episode attributes					
Trip Type			**Metropolitan Region**		
Recreational	457	29%	Yes	1402	89%
Utilitarian	1126	71%	No	181	11%
Time of Day			**Day of the week**		
Morning (5:00 – 9:00 AM)	411	26%	Weekend	733	46%
Evening (3:30 – 7:30 PM)	462	29%	Weekday	850	54%
Mid-day or night (rest)	710	45%	**Duration**		
Social interaction during walking			Less than 10 minutes	469	30%
Yes	743	47%			
No	840	53%	10 minutes to 20 minutes	645	40%
Child(ren) accompanying on Trip					
Yes	215	14%	More than 20 minutes	469	30%
No	1368	86%			

The sample exhibits an age distribution that has smaller percentages in the first and last age groups and nearly three-quarters of the records are reported by individuals between 20 and 65 years of age. The sample is rather evenly split between men and women. A majority of the records (54%) are reported by employed individuals.[3] The sample records also are rather evenly split across various education levels, with a total of 60% falling into categories of some college education or higher. More than 70% of the records are reported by Whites and 82% of the records are reported by non-Hispanics.

The sample is rather split with respect to their own assessment of health conditions; 55% indicate that they feel good about their health, but 45% indicate otherwise, suggesting that individuals are rather wary about their health condition. Only six percent of records, however, are reported by those with difficulty walking; it is possible that a slightly higher percent of unique individuals have difficulty walking (as they are likely to be largely absent in a walking episode file). The income distribution shows a spread across all income categories; 19% of the walk episodes are reported by those with household incomes of $100,000 or more. The household size distribution shows that one-third of the records are reported by single persons, and another 22% by persons in two-person households. Accordingly, 60% of the walking episodes are reported by individuals in zero-child households. About one-third of the records correspond to single-person households, 20% to couple-households, and 23% to nuclear family households. Only seven percent of records are reported by single parent households, suggesting that their presence is small in the sample and they may not be able to engage in substantial amounts of walking due to time and child care constraints.

In terms of walking episode attributes, 71% of the episodes are utilitarian – suggesting that most walking events have an activity purpose at the destination. Just over one-quarter take place in the morning hours (5AM to 9AM), and another 29% take place in the afternoon hours (3:30PM to 7:30PM). A majority of records (53%) does not involve social interaction of any kind (including telephone conversations); 86% of records involve no child accompaniment. Most walking episodes are undertaken by individuals living in metropolitan areas, and the episodes are about equally split between weekend days and weekdays, suggesting a higher intensity of walking episodes over the weekend days. In terms of walking episode duration, 30% are than less than 10 minutes and another 30% are more than 20 minutes.

The dependent variables in the model system developed in this paper are the five emotions. The means and standard deviations of the five emotions for the two types of walking episodes are presented in Table 2. The means are on a scale of zero to six. The average happiness and meaningfulness scores are higher for recreational walking episodes than utilitarian walking

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[3] Note that the 54% of episodes (of the 1583 episodes) contributed by employed individuals is commensurate with the 54% of individuals (of the 1326 individuals) who are employed in the sample. That is, the frequency distribution of the number of episodes contributed by employed individuals and unemployed individuals are about the same. Thus, it is not the case in our sample that employed and unemployed individuals contribute very different numbers of episodes on a per individual basis (the ratio of the number of episodes to individuals is 1.208 among employed individuals and 1.177 among unemployed individuals). Also, important to note is that the percentage of individuals employed in our sample reasonably closely reflects the percentage of individuals in the US population who were employed in 2012. According to the Bureau of Labor Statistics (see https://www.bls.gov/opub/ted/2012/ted_20120911_data.htm), the labor force participation rate was 63-64% (say 63.5%) in 2012, with an unemployment rate of 8.2%. Thus, the employment rate may be derived as 63.5*(0.918)=58%. Thus, our sample has a slightly lower percentage of employed individuals, but not dramatically less so than the US population percentage of employed individuals in 2012.

episodes. This is consistent with expectations, as recreational walking episodes are likely to be relaxing in nature and taking place in pleasant environments such as parks and green spaces. Utilitarian walking is viewed as slightly less painful; it is likely that some of the recreational walking episodes are vigorous/intensive activities meant to boost health and fitness – such activities may result in some pain. Utilitarian walking episodes are more stressful and result in a higher level of tiredness. The latter result is somewhat counter to expectations, but it is possible that fatigue sets in when undertaking a walking activity that is not relaxing and pleasant.

TABLE 2 Emotion Ratings for Utilitarian and Recreational Walking Episodes

Emotions	Utilitarian Walking (N=1126)		Recreational Walking (N=457)		Total (N=1583)	
	Mean	95% C.I.	Mean	95% C.I.	Mean	95% C.I.
Happiness	4.35	[4.27, 4.43]	4.87	[4.80, 4.94]	4.50	[4.42, 4.58]
Meaningfulness	3.98	[3.88, 4.08]	4.94	[4.86, 5.02]	4.26	[4.16, 4.36]
Painfulness	0.92	[0.84, 1.00]	1.02	[0.94, 1.10]	0.95	[0.87, 1.03]
Stressfulness	1.29	[1.21, 1.37]	0.93	[0.85, 1.01]	1.19	[1.11, 1.27]
Tiredness	2.19	[2.09, 2.29]	1.78	[1.69, 1.87]	2.07	[1.97, 2.17]

Note: Means are based on a measurement scale of 0-6; C.I. stands for Confidence Interval

4 METHODOLOGY

A multivariate ordered modeling framework is adopted in the current study so that the five emotions may be considered jointly. The underlying reason for proposing a multivariate analysis is that the five emotions are jointly observed and not mutually exclusive; hence, a joint multivariate model would better capture the effects of exogenous variables on the emotion outcomes while also accounting for correlated unobserved attributes that affect multiple emotions through the specification of an appropriate error covariance structure on the underlying latent propensities.

Ordered ratings for each of the five emotions are observed for each walk episode. The key objective of this paper is to understand the differential effects of various exogenous variables on emotions associated with recreational and utilitarian walking episodes. To accommodate this, an interaction approach is used wherein various socio-demographic and episode attributes are interacted with a *utilitarian* purpose indicator in the model specification. This approach entails using the same error correlation matrix (across the emotions) for both walk types, thus providing simplicity and parsimony in model structure.

The rest of this section briefly describes the mathematical formulation of the multivariate ordered model framework used in this study. Let q be an index for individuals (q = 1, 2, …, Q), and let i be the index for emotion (i = 1, 2, …, I, where I denotes the total number of emotion variables for each individual; in the current study, I = 5). Let the number of ordinal levels for the emotion variables be K + 1 (*i.e.*, the response of an emotional rating is indexed by k and belongs in {0,1, 2, …, K}). There is no need to index K by i because all emotion types are collected on the same seven-point ordinal scale. Following the usual ordered response framework notation, the latent propensity (y^*_{qi}) for each emotion variable is written as a function of relevant covariates and this latent propensity is related to the observed count outcome (y_{qi}) through threshold bounds (McKelvey and Zavoina, 1975):

$$y^*_{qi} = \beta_i' x_{qi} + \varepsilon_{qi}, y_{qi} = k \text{ if } \theta_i^k < y^*_{qi} < \theta_i^{k+1}, \tag{1}$$

where x_{qi} is a $(L \times 1)$ vector of exogenous variables (not including a constant), β_i is a corresponding $(L \times 1)$ vector of coefficients to be estimated, ε_{qi} is a standard normal error term, and θ_i^k is the lower bound threshold for count level k of emotion variable i ($\theta_i^0 < \theta_i^1 < \theta_i^2 ... < \theta_i^{K+1}$; $\theta_i^0 = -\infty$, $\theta_i^{K+1} = +\infty$ for each emotion variable i). The ε_{qi} terms are assumed independent and identical across individuals (for each and all i). Due to identification restrictions, the variance of each ε_{qi} term is normalized to 1. However, correlations are allowed in the ε_{qi} terms across emotion variables i for each individual q. Specifically, define $\varepsilon_q = (\varepsilon_{q1},\ \varepsilon_{q2},\ \varepsilon_{q3}, ... ,\ \varepsilon_{qI})'$. Then, ε_q is multivariate normal distributed with a mean vector of zeros and a correlation matrix as follows:

$$\varepsilon_q \sim N\left[\begin{pmatrix} 0 \\ 0 \\ \vdots \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho_{12} & \rho_{13} & \cdots & \rho_{1I} \\ \rho_{21} & 1 & \rho_{23} & \cdots & \rho_{2I} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \rho_{I1} & \rho_{I2} & \rho_{I3} & \cdots & 1 \end{pmatrix}\right], \text{ or} \tag{2}$$

$$\varepsilon_q \sim N\left[\mathbf{0}, \mathbf{\Sigma}\right]$$

The off-diagonal terms of $\mathbf{\Sigma}$ capture the error covariances among the underlying latent continuous variables of the different emotion variables; that is, they account for the presence of common unobserved factors influencing the intensity outcome for each emotion variable. Thus, if ρ_{12} is positive, it implies that individuals with a higher than average propensity to report high levels for the first emotion variable are also likely to have a higher than average propensity to report high levels for the second emotion variable. If all correlation parameters (*i.e.*, off-diagonal elements of $\mathbf{\Sigma}$) stacked into a vertical vector, $\mathbf{\Omega}$, are identically zero, the model system in Equation (1) collapses to a series of independent ordered response probit models for each emotion variable.

The parameter vector of the multivariate probit model is $\delta = (\beta_1', \beta_2', ..., \beta_I';\ \theta_1', \theta_2', ..., \theta_I';\ \Omega')'$, where $\theta_i = (\theta_i^1,\ \theta_i^2,\ ...,\ \theta_i^K)'$ for $i = 1, 2, \ldots, I$. Let the actual observed emotion level for individual q and emotion variable i be m_{qi}. In that case, the likelihood function for individual q may be written as follows:

$$L_q(\delta) = \Pr(y_{q1} = m_{q1}, y_{q2} = m_{q2}, ..., y_{qI} = m_{qI})$$

$$L_q(\delta) = \int_{v_1 = \theta_1^{m_{q1}} - \beta_1' x_{q1}}^{\theta_1^{m_{q1}+1} - \beta_1' x_{q1}} \int_{v_2 = \theta_2^{m_{q2}} - \beta_2' x_{q2}}^{\theta_2^{m_{q2}+1} - \beta_2' x_{q2}} \cdots \int_{v_I = \theta_I^{m_{qI}} - \beta_I' x_{qI}}^{\theta_I^{m_{qI}+1} - \beta_I' x_{qI}} \phi_I(v_1, v_2,\ ..., v_I \mid \Omega) dv_1 dv_2 ... dv_I \tag{3}$$

$\phi_I(.,.,...)$ in the above expression represents the standard multivariate normal density function. Calculating the high-order I-dimensional rectangular integral in Equation (3) is computationally challenging. However, the idea behind a recent efficient matrix-based approach, known as the one variate univariate screening (OVUS) devised by Bhat (2018), has been used to compute the rectangular integral shown above and estimate coefficients of the multivariate ordered response model. The mathematical formulations for the method have been omitted for brevity and may be found elsewhere (Bhat, 2018).

5 RESULTS

The final model specification was obtained based on a systematic process of testing alternative combinations of explanatory variables and eliminating statistically insignificant ones. However, some variables that were not statistically significant at a 95% confidence level were still retained due to their intuitive interpretations and important empirical implications. Also, these effects, even if not highly statistically significant, can inform specifications in future investigations with larger sample sizes. Additionally, for the continuous variables of respondent age and respondent's household income, a number of functional forms were tested, including a linear form, a dummy variable categorization, as well as piecewise spline forms. But the dummy variable specification turned up to provide the best data fit in all cases, and is the one adopted in the final model specification.

Model estimation results are presented in Table 3. For ease in presentation, we do not provide the threshold values that map each underlying emotion propensity to the observed ordinal category (these thresholds do not have any substantive behavioral interpretations). The model specification includes both socio-economic variables and walking episode attributes as explanatory factors that influence the levels of various emotions experienced. A key objective of this study is to differentiate how people feel about utilitarian and recreational walk episodes. As there may be considerable heterogeneity in how people feel about these two distinct types of walking episodes, the model specification includes a number of interaction variables (which turned out significant and offered behaviorally intuitive interpretations) where socio-demographic indicators and walking episode attributes are interacted with an indicator corresponding to utilitarian walk episode type. The coefficients should be interpreted appropriately. If a socio-demographic/walk attribute variable has only a pure form effect (that is, its interaction with the utilitarian episode type is not statistically significant), it implies that the corresponding coefficient denotes the influence on the underlying (continuous latent) emotional feeling for *any* walk episode (that is, there is no differential effect of the variable on emotional feelings between the utilitarian and recreational episode types). But if a socio-demographic/walk attribute variable has both statistically significant pure form as well as interaction (with the utilitarian episode type indicator) effects, the pure form effect captures the influence on the underlying emotion for the *recreational episode type*, while the interaction effect captures the *differential* influence on the underlying emotion between utilitarian and recreational episode types. By the same token, if a socio-demographic/walk attribute has an effect in its pure form, and an opposite effect of about the same magnitude in its interaction form, this implies that the attribute influences emotion for the recreational walk episode (with no influence of the attribute on emotion for the utilitarian episode type). Finally, if a socio-demographic/walk attribute variable has only an interaction effect (that is, the pure form effect is not statistically significant), the corresponding interaction coefficient provides the impact on emotion for the *utilitarian walk episode type* (with no influence of the socio-demographic/walk attribute on emotion for the recreational episode type). The remainder of this section offers an interpretation of model estimation results together with an assessment of model goodness-of-fit. The coefficients in Table 3 provide the effects of variables on the continuous (latent) propensity underlying each of the emotions. In the ensuing discussion, statements such as "higher levels of happiness" will be taken to mean higher scores on this continuous (latent) propensity.

5.1 Influence of Socio-demographic Variables

The first row of Table 3 offers a baseline indicator of the emotions people derive from utilitarian walk relative to recreational walk. In general, the utilitarian walk is rated significantly lower on the happiness scale and significantly higher on the tiredness scale; the other three emotions of meaningfulness, painfulness, and stress do not exhibit statistically significant differences between utilitarian and recreational walk episodes.

Age Effects: Older individuals (above age 50) derive greater happiness and meaningfulness from and report lower levels of tiredness for walking episodes. On the other hand, those in the younger age groups (50 years and less) report higher levels of pain. Older individuals are likely to be retired or residing in empty nest households (without child-care obligations); they are likely to be at a stage of life where they are well established and relaxed in terms of their daily activity patterns and time pressure (Beekman, 2011). They may also engage in more slow-paced walk episodes; thus, they derive greater pleasure and are less tired. Younger individuals may engage in more physically intensive walk episodes (for health reasons and to lead a more active lifestyle), contributing to higher levels of pain.

Gender Effect: Women generally report higher levels of happiness and lower levels of stress (than do men) for walking episodes in general. They are also found to experience higher levels of tiredness (compared to men) for utilitarian walking. Additionally, women find recreational walking more meaningful than males; however, this heightened sense of meaningfulness for women for walking all but vanishes for utilitarian walk. Traditional gender roles in which women shoulder greater household responsibilities (Lee and Lichter, 1991), physiological differences between men and women (Hoyenga and Hoyenga, 1982), and the higher level of health consciousness among women (Wardle et al., 2004) may all be factors that contribute to these findings.

Race/Ethnicity Effects: Race and ethnicity also appear to be important determinants of the emotional states associated with walking. Whites (compared to non-Whites) generally find walking episodes to be less meaningful, and more painful, stressful, and tiring. When compared with non-Hispanics, Hispanics tend to experience higher levels of meaningfulness and lower levels of stress and tiredness from walking episodes, irrespective of the purpose. It is plausible that there are cultural differences across ethnic groups that contribute to varied emotional ratings for walking episodes (Pucher et al., 2011). The results also indicate that Hispanics derive higher levels of happiness and lower levels of pain for recreational walk episodes; however, these variations (between Hispanics and Non-Hispanics) in the states of happiness and pain is substantially tempered for the utilitarian purpose to the point of no statistically significant difference based on ethnicity.

TABLE 3 Estimation Results for Multivariate Ordered Probit Model of Emotions

Variables	Coefficient estimate (t-stat values)				
	Happy	Meaningful	Pain	Stress	Tired
Utilitarian walk (*base:* Recreational walk)	-0.384 (-2.41)	-0.056 (-0.24)	-0.083 (-0.99)	0.104 (0.73)	0.281 (2.87)
Socio-demographic variables					
Age					
Less than 20 years (*base)*	--	--	--	--	--
20-35 years	0.000	0.343 (2.83)	0.352 (3.82)	0.285 (3.95)	0.000
36-50 years	0.000	0.570 (4.80)	0.473 (4.90)	0.347 (4.82)	0.000
51-65 years	0.315 (4.43)	0.697 (5.45)	0.246 (2.67)	0.000	-0.380 (-5.44)
Over 65 years	0.534 (6.12)	0.987 (7.13)	0.000	0.000	-0.358 (-4.33)
Gender					
Female (*base:* Male)	0.169 (2.94)	0.369 (3.12)	0.000	-0.130 (-2.24)	0.000
Female*Utilitarian	0.000	-0.255 (-1.91)	0.000	0.000	0.098 (1.56)
Race and Ethnicity					
White (*base:* Non-white race)	0.000	-0.223 (-3.45)	0.166 (2.31)	0.144 (2.16)	0.097 (1.55)
Hispanic (*base:* Non-Hispanic)	0.433 (2.85)	0.443 (5.39)	-0.468 (-2.53)	-0.209 (-2.49)	-0.224 (-2.92)
Hispanic*Utilitarian	-0.210 (-1.26)	0.000	0.362 (1.82)	0.000	0.000
Employment					
Employed (*base:* Unemployed)	0.074 (1.40)	0.246 (1.87)	-0.170 (-2.44)	0.000	0.000
Employed*Utilitarian	0.000	-0.276 (-1.91)	0.000	0.000	0.000
Education					
High School or lower (*base)*	--	--	--	--	--
Associate/Bachelor's degree	0.000	0.000	0.000	0.000	0.000
Associate/Bachelor's degree*Utilitarian	0.000	-0.136 (-1.78)	0.000	0.000	0.000
Post Graduate (Master's or higher)	-0.185 (-2.11)	0.000	0.000	0.113 (1.26)	0.111 (1.53)
Post Graduate*Utilitarian	0.000	-0.220 (-1.84)	0.000	0.000	0.000

Variables	Coefficient estimate (t-stat values)				
	Happy	Meaningful	Pain	Stress	Tired
Physiological difficulty in walking and health					
Physiological difficulty in walking (*base:* No difficulty)	-0.433 (-2.22)	-0.225 (-1.78)	0.787 (5.86)	0.627 (3.15)	0.772 (4.17)
Physiological difficulty in walking*Utilitarian	0.387 (1.70)	0.000	0.000	-0.455 (-1.91)	-0.469 (-2.27)
Individual self-reports health as good, very good or excellent (*base:* reports fair or poor)	0.334 (5.50)	0.208 (3.28)	-0.628 (-8.80)	-0.332 (-4.95)	-0.369 (-6.08)
Household income					
Annual Household income < $20,000 (*base)*	--	--	--	--	--
Annual Household Income $20,000-49,999	-0.236 (-1.64)	0.000	0.000	0.000	0.000
Annual Household Income $50,000 or higher	-0.337 (-2.32)	0.000	0.000	0.000	0.000
Annual Household Income $20,000-49,999*Utilitarian	0.273 (1.69)	0.000	0.000	-0.146 (-1.78)	0.000
Annual Household Income $50,000 or higher*Utilitarian	0.263 (1.60)	-0.139 (-1.62)	0.000	-0.088 (-0.97)	0.000
Household structure and involvement					
At least one child in the household (*base:* No child)	0.000	0.180 (2.09)	-0.103 (-1.45)	0.180 (2.47)	0.000
Single person household (*base:* Household size > 1)	0.000	0.119 (1.50)	0.000	-0.064 (-0.81)	0.000
Individual spends at least 4 non-work hours with family (*base:* Less than 4 hours)	0.000	0.206 (2.86)	0.000	-0.228 (-3.39)	0.000
Walk episode attributes					
Duration and Social interaction					
Duration of walk greater than 20 minutes (*base:* Duration less than 20 mins)	0.000	0.231 (2.81)	0.000	0.000	0.164 (2.03)
Social interaction while walking (*base:* No interaction)	0.393 (3.72)	0.168 (2.69)	0.000	0.000	0.000
Social interaction while walking*Utilitarian	-0.188 (-1.57)	0.000	0.000	0.000	0.000
Child accompaniment					
Child(ren) accompaniment (*base:* No child accompaniment)	0.354 (3.97)	0.226 (1.97)	0.000	0.000	0.000
Child(ren) accompaniment*Utilitarian	0.000	0.000	-0.181 (-1.49)	0.000	0.000
Metropolitan region residence					
Metropolitan region (*base:* Non-metropolitan region residence)	0.000	-0.330 (-1.78)	0.000	0.000	0.000
Metropolitan region*Utilitarian	0.000	0.253 (1.20)	0.000	0.305 (2.57)	0.000

Variables	Coefficient estimate (t-stat values)				
	Happy	**Meaningful**	**Pain**	**Stress**	**Tired**
Day of the week					
Weekend (*base:* Weekdays)	0.000	0.000	0.000	0.000	-0.169 (-3.21)
Weekend*Utilitarian	0.110 (1.77)	0.000	0.000	-0.169 (-2.49)	0.000
Time of day					
Mid-day or Night (*base*)	--	--	--	--	--
Morning	0.321 (2.79)	0.180 (2.64)	0.000	0.000	0.000
Morning*Utilitarian	-0.326 (-2.43)	0.000	0.000	0.120 (1.46)	-0.159 (-2.11)
Evening	0.083 (1.27)	0.000	0.000	-0.150 (-2.18)	0.125 (2.01)
Evening*Utilitarian	0	0.000	0.000	0.000	0.000

Goodness-of-Fit Summary statistics	**Joint model**	**Independent model**
Log likelihood at convergence	-11,160.15	-11,620.20
Log likelihood at constants	-12,190.95	-12,190.95
Number of parameters	102	92
Adjusted likelihood ratio index	0.0762	0.0328
Average probability of correct prediction	0.0186	0.0097
Likelihood Ratio Test (LRT) between the Joint and Independent models	χ^2 = -2[-11620.20 – (-11160.15)] = 920.1, 10 *df*, p=0.000	

NOTE: 0.000 values indicate that the variables were statistically insignificant. -- indicates the base category

Employment Effects: Employed individuals, who may experience work-related stresses and may be confined to indoor workplaces for extended periods of time, report higher levels of happiness for walking episodes than unemployed individuals. Employed individuals also find recreational walks to be more meaningful when compared to unemployed individuals; however, when the walk is utilitarian in nature, there is little difference between employed and unemployed individuals. Employed individuals report a lower level of painfulness for walking episodes, presumably because they are more active during the day and find walking to be less bothersome (from a physical standpoint) than the unemployed (Kwak et al., 2016).

Education Effects: The highest level of education (post-graduate education) is associated with lower happiness and higher stress and tiredness for walking episodes. It is likely that those with such high education achievement are in stressful and exhausting jobs and work long hours (leading to time pressure). As a result, they derive less happiness and experience greater levels of stress and tiredness. When the episode is utilitarian, meaningfulness is the lowest for this highly educated group relative to other groups. The literature suggests that more educated individuals walk more (*e.g.,* Kruger et al., 2008); while that may be true, the findings in this paper suggest that they derive a lower sense of positive emotions from the walking that they do.

Physical Health Effects: As expected, those who have physiological difficulty in walking report lower levels of meaningfulness and higher levels of pain for any walk episode. Additionally, they experience higher levels of stress and tiredness, and lower levels of happiness for recreational walking. Walking is more challenging for these individuals and hence the emotional ratings are likely to be more negative than for people who do not experience difficulty walking. Likewise, individuals who indicate that they are in good health report higher levels of happiness and meaningfulness, and lower levels of stress, tiredness, and painfulness, for walking episodes (Perneger et al., 2004). Those who have physiological difficulty walking report a gain in happiness and reduction in stress and tiredness for utilitarian walking episodes. It is likely that utilitarian episodes provide these individuals with a sense of purpose and accomplishment, thus contributing to more positive feelings (note though that, even for these utilitarian episodes, those with physiological difficulty walking associate lower levels of happiness and higher levels of stress compared to those without any physiological difficulty).

Household Income Effects: Household income is another key determinant of well-being associated with walking episodes. Individuals in progressively higher income households report lower levels of happiness for recreational walking episodes relative to their lower income counterparts. This is presumably because individuals in these households are working, under greater time pressure/constraints with lower time availability for leisure activity, and used to traveling in the comfort of mechanized modes (Bellezza et al., 2016; Sullivan, 2008; Börjesson et al., 2012); as a result, recreational walking is not necessarily an activity that yields positive feelings of emotion for these individuals. However, higher income individuals view utilitarian walking episodes more positively from a happiness standpoint than how they view recreational episodes, presumably because these episodes result in the fulfillment of activities or goals (relatedly, happiness levels for utilitarian walking effectively do not vary by household income levels).

Household Structure Effects: Individuals residing in households with children report a higher level of meaningfulness and a higher level of stress for walking episodes. It is likely that these individuals face greater levels of stress and time pressure in the context of fulfilling household and child-care obligations. However, the walking episodes may provide an important respite from the stresses of household obligations, thus providing meaningfulness. Also, if the individual is walking with a child (say, to and from school or to and from a park), then the walking episode may engender parent-child interaction that is valued and meaningful (Östberg and Hagekull, 2000; Conger et al., 1995; Meltzer and Mindell, 2007). Single persons, who do not have the same household responsibilities that persons in other types of households may have, report greater level of meaningfulness and lower level of stress for walking episodes – presumably because they are less time-pressured and can take the time to enjoy the walking activity (Yetter, 2010). Likewise, individuals who spend more time with family report greater meaningfulness and lower stress for walking episodes, presumably because they do not have the same time constraints as those who spend less time with family.

5.2 Influence of Walk Episode Attributes

A number of attributes of the walk episodes themselves affect people's ratings on various emotional feelings. The remaining explanatory variables in Table 3 constitute characteristics of the walk episodes.

Walk Duration Effects: In general, a longer walk (in duration) is associated with a higher level of meaningfulness, presumably because longer recreational walks offer greater restorative benefits while longer utilitarian walks offer a sense of accomplishment while integrating physical activity in a time-efficient way. Ekkekakis et al. (2008) notes that walking episodes that do not exceed a certain duration are "presumed to lack sufficient potency to improve affect". As expected, longer walks are reported to be more tiring.

Social Interaction Effects: Social interaction during any walk episode enhances meaningfulness, consistent with the notion that interaction can be stimulating and revitalizing (Johansson et al., 2011; Plante et al., 2011). Happiness levels of recreational walking are also heightened by social interaction, especially for recreational episodes (with this heightened happiness effect of social interaction, while still being present, reducing in intensity for utilitarian episodes relative to recreational episodes). These positive social interaction effects on happiness and meaningfulness (for both types of walking) are amplified when the walks are characterized by child accompaniment, and the negative emotion of pain is diminished for utilitarian walks presumably because of the emotional bonds people enjoy with children and the sense of accomplishment that comes with task completion.

Metropolitan Region Residence Effects: Walks in metropolitan regions are viewed as less meaningful, especially for recreational episodes, presumably because of the more chaotic built environment characterized by traffic, pollution, and crowds; hence they do not offer the relaxing restorative benefits that walks in non-metropolitan environments offer. However, within the segment of metropolitan residents, individuals seem to find more meaningfulness in utilitarian walking than recreational walking. Also, metropolitan residents associate more stress with utilitarian walking relative to their non-metropolitan resident peers. These findings are consistent with expectations – the chaotic environment leads to a greater degree of stress as documented in prior research (Lederbogen et al., 2011), but the higher degree of accessibility and opportunity afforded by dense urban environments helps elevate the meaningfulness of utilitarian walks (which are undertaken to accomplish a task or activity) relative to recreational walks for metropolitan residents.

Day of Week Effects: Walks on weekends are less tiring, possibly because weekends are associated with relaxed mood in general and a higher time budget (Helliwell and Wang, 2014). Moreover, utilitarian walks are associated with an elevated level of happiness and diminished level of stress on weekends. This is consistent with expectations; people tend to be happier and more relaxed on weekends and the activities pursued (at the destination) following utilitarian walks are more likely to be enjoyable activities (Helliwell and Wang, 2014, Tadic et al., 2012).

Time of Day Effects: Finally, the time-of-day indicators have coefficients that suggest that morning recreational walks (relative to the mid-day and periods of nighttime) are associated with positive feelings of being happy. Walks of any nature during the morning period are also associated with the highest intensity of meaningfulness relative to walking pursued at any other time of the day. These results presumably may be attributable to the elevated mood in the mornings (Wood and Magnello, 1992). Evening walks for both recreational and utilitarian episodes are also associated with an elevated level of happiness relative to the mid-day and night periods, though not to the same extent as morning recreational walks. Evening walks for all types of walking episodes are the least stressful, but also the most tiring, relative to walks undertaken at any other period of the day. In the evening, people may be more relaxed as the day is winding down (hence less stress) and may pursue more intensive physical activity as part of a fitness regimen (hence more tiring) (Stone et al., 2006, Kahneman et al., 2004).

5.3 Goodness-of-Fit and Error Correlations

Model goodness-of-fit measures are shown at the bottom of Table 3. In addition to the joint model, an independent ordered probit model system was estimated by setting all error correlations to zero. The relative performance of the joint and independent models was assessed by comparing standard goodness-of-fit metrics. The adjusted likelihood ratio index for the joint model is twice that for the independent model, suggesting that the joint model offers a superior goodness-of-fit relative to the independent model. The likelihood ratio test (LRT) between the joint and independent models yields a statistically significant χ^2 statistic at any degree of confidence.

The efficacy of the joint model is further demonstrated by the significant error correlations that were obtained. In the interest of brevity, the error correlation matrix is suppressed in Table 3, but all of the error correlations were found to be statistically significant at the 95% confidence level. The error correlations were behaviorally intuitive; the error terms associated with the positive emotions (happiness and meaningfulness) were positively correlated as were the error terms associated with the negative emotions (pain, stress, and tiredness). In other words, unobserved attributes that contribute to an individual feeling happy also contribute to an individual experiencing meaningfulness; the same logic applies for negative emotions. The correlation terms across positive and negative emotions are, as expected, negative. In other words, unobserved attributes that contribute to an individual being happy or experiencing meaningfulness are negatively correlated with unobserved attributes that contribute to an individual feeling pain, stress, or tiredness. These findings are entirely consistent with expectations and call for the estimation of a joint model that accommodates error correlations so that consistent parameter estimates (on the explanatory variables) may be obtained.

The performance of the joint model was compared to that of the independent model by comparing predictions obtained from the two models. The average probability of correct prediction is shown in Table 3; the joint model provides a higher value than the independent model (these values are low simply because of the very large number of possible combinations). For each of the walk episodes, there are 7^5 possible combinations of emotion outcomes (five emotion types and seven possible rating values) and the number of combinations doubles because there are two walking episode types (the explosion in the number of combinations is the reason for what may seem as a relatively small average probability of correct prediction). To facilitate a more tractable comparison between the two models, the seven-point rating scale was converted to a binary scale (by combining ratings of 0 through 3 into one level, and 4 through 7 into another level) and only bivariate pairings of emotions were considered in the comparison (*e.g.*, happy-meaningful; happy-painful; happy-stressed; and so on). Predictions from the models were compared to observed numbers of observations falling into various categories for each of the bivariate combinations. The absolute percent error (APE) in prediction was computed for each bivariate combination category and compared between the joint and independent models. The results (suppressed in the interest of brevity) clearly show that the joint model provides a lower APE consistently across all combinations considered for both recreational and utilitarian walking episodes. Across all combinations, the average APE for the joint model was 5.88, while the average APE for the independent model was 20.15. Clearly, all the fit measures demonstrate the clear superiority of the joint model for modeling multiple emotions simultaneously.

5.4. Policy Implications

The findings have important planning and policy implications. In general, utilitarian walking episodes are not viewed as favorably as recreational walking episodes. In other words, even though individuals need to carve additional time out of the day to undertake recreational walking episodes (potentially consuming more of a scarce resource, *i.e.*, time), these are the walks that people generally enjoy more. A utilitarian walking episode can serve multiple purposes – fulfilling an activity at a destination as well as providing health/fitness benefits – and yet such episodes are not viewed as favorably. Utilitarian walking episodes are likely undertaken in a more time-constrained setting (*e.g.*, rushing to work or school) and in a location/space where the surrounding environment is not as pleasant and peaceful. Recreational walking episodes are likely to be more relaxing and undertaken in a pleasant green space or park at a time that is convenient and less time-constrained. In other words, it would appear that investments in recreational parks and green spaces may pay rich dividends in encouraging (recreational) walking among people; investments in sidewalks along streets (with a view to shift mode choice and motivate utilitarian walks) may not necessarily yield the same returns on investment simply because people do not enjoy utilitarian walks as much (and, with a few minor exceptions, the effect is amplified for a number of groups). If utilitarian walking is to increase, then the building of pedestrian infrastructure needs to be combined with a host of additional strategies such as perhaps creating more nature-inspiring landscapes, creating greater buffer distances between pedestrians and moving traffic, creating a sense of place in the walking environment, slowing traffic to speeds that are less intimidating, and creating pedestrian-only zones. Similarly, locations of transit stops and parking facilities may be determined on a more strategic basis; transit stops can be located such that walking to and from transit stops is more pleasant and parking facilities can be located such that vehicles do not impinge upon walking environments.

There is considerable observed heterogeneity in terms of the extent to which people derive positive or negative emotions from walking. Age, gender, employment, race and ethnicity, and household structure are all key determinants of emotions associated with walking. Awareness campaigns regarding the ill effects of obesity and inactive lifestyle can be strategized to promote walking among specific subgroups that are less inclined to walk. For example, teenagers and young adults (less than 20 years of age) do not view walking (for both utilitarian and recreational purposes) as being as meaningful as older adults. Given the eudaimonic nature of this emotion, and the importance of this emotion in longer-term persistence of walking, strategies aimed at introducing a sense of purpose to walking in early adulthood appears warranted. Doing so is particularly important because earlier studies have indicated that attitudes/behaviors learned during early adulthood are more likely to stay through the lifetime of the individual (Long et al., 2019). Of course, inculcating a sense of meaningfulness to young adults can also have immediate benefits in terms of physical and mental health. Importantly, it is not adequate to simply implement walking programs, but instantiate a sense of choice and freedom in the programs by keeping programs simple, not overcomplicating things, and associating walking with enjoyment, inclusion and social participation. Especially when combined with our result that social interaction during walking increases a sense of meaningfulness, our results suggest that high schools and communities should institute programs such as "Walk to School" days, and families can be encouraged to walk with their teenagers (see Greatschools Staff, 2013). Another interesting result from our analysis is that individuals who are non-Hispanic and White are found to associate significantly higher levels of negative emotions with walking. This may suggest a need to target information dissemination campaigns regarding the benefits of walking to such specific socio-demographic groups.

Additionally, walk episode attributes like duration of walk episodes, day of the week, time of the day, metropolitan/non-metropolitan environment, whether an individual was socially interacting or accompanied by child(ren) also impact the levels of the different emotions experienced while undertaking a walk episode (with some of these variables having a differential impact on the emotional outcomes based on the type of walk – utilitarian or recreational). The finding that individuals find walking more enjoyable (positive) on weekends suggests that special interventions on weekends may engender additional walking (*e.g.*, designating certain areas as walk-only zones on weekends; implementing weekend parking restrictions; and holding special events on weekend days).

The bottom line is that simply building sidewalks along thoroughfares and hoping people will use them as part of their daily activity-travel agenda is likely to be an exercise in futility. Strategic investments in green spaces to increase recreational walking, and interventions in street environments to provide a more pleasant/safe walking environment to increase utilitarian walking, are needed and should be considered.

6 CONCLUSIONS

Lack of data about emotional feelings associated with activity engagement has generally precluded the ability to undertake such an analysis to understand and quantify the immediate emotions engendered by a walking experience. The American Time Use Survey (ATUS) data set, however, includes a well-being module in the 2010, 2012, and 2013 versions of the survey; the subjective ratings on six different emotions of happiness, sadness, meaningfulness, tiredness, stress, and painfulness can be used to understand how people feel in the context of the activity episode in question. This data has been used in this study to understand emotions associated with walking episodes.

Utilitarian and recreational walks are considered separately to better understand differences in how socio-demographic characteristics and walking episode attributes influence feelings of emotions that people derive from the two types of walking episodes. A multivariate ordered probit model of ratings on five of the six emotions (all emotions except for sadness) is estimated to determine the factors that affect feelings associated with different types of walking episodes. The model structure allows error correlations across the different emotions, thus accommodating for the presence of correlated unobserved attributes that simultaneously affect multiple emotions. In addition, the model specification includes a number of interaction variables to determine the differential effect that socio-economic and demographic variables and walking episode attributes may have on the emotions derived from different types of walking episodes.

Model estimation results show that people generally derive a lower sense of positive emotions (happiness and meaningfulness) from utilitarian walking episodes (when compared with recreational walking episodes). There is considerable observed heterogeneity in terms of the extent to which people derive positive or negative emotions from walking, and walk episode attributes also impact the levels of the different emotions experienced while undertaking a walk episode. The findings have important planning and policy implications

The present study makes a novel attempt to model how people feel during walk episodes. To our knowledge, this is the first rigorous analysis of multiple emotions experienced during walk episodes, accounting for correlations that exist across the emotions as well as differentiating between recreational walk episodes and utilitarian episodes. A host of demographic and walk episode attributes are considered in explaining the different emotions. Of course, a limitation of the data is that the ATUS collected emotions for three randomly selected (by the respondent) activity episodes, as opposed to emotions for all walk episodes. As a result, it is very possible that the sample of walk episodes used in the analysis is not representative of the population of walk episodes undertaken. However, there is no reason to believe that the relationships between emotions and its determinants will be affected by this situation. In any case, to get a more representative and larger sample pool of walk episodes and corresponding emotions, it would be beneficial to collect data on emotions on all walk episodes as part of future activity-travel and time use surveys. Detailed information about the built environment was also lacking in the data set used for this study, and future research should strive to include such secondary land use data in modeling efforts. Similarly, weather-related factors could play a vital role in any walk experience, which, unfortunately, could not be incorporated in this study due to unavailability of such weather data. It would also be beneficial to disaggregate the utilitarian purpose into sub-categories such as walking to work, walking for groceries, and walking for errands so that effects of covariates on emotions associated with different types of utilitarian walking episodes can be disentangled. From a methodological perspective, more general non-normal multivariate distributions may be used for implementing error correlations across the many emotions to relax the normality assumption imposed on the (latent) continuous propensities underlying the emotion ratings.

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