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 emotional feelings of well-being associated with different types of walking episodes – namely, recreational walking episodes that are undertaken with no specific purpose, and utilitarian walking episodes that are undertaken with the purpose of fulfilling an activity at a destination. A knowledge of the emotions associated with different types of walking episodes can help steer policies, interventions, 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 episodes in the time use file. 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 negative emotions associated with utilitarian walk episodes are amplified for a number of socio-demographic groups. The results suggest that investments in recreational walking infrastructure and green spaces may yield richer dividends in terms of engendering higher levels of walking among the public.

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

1. INTRODUCTION

Sedentary lifestyle due to insufficient physical activity is a major health concern in many developed and industrialized nations, including the United States. According to the U.S. National Health Interview Survey (Blackwell et al., 2002), about 34% of adults in the U.S. were overweight and about 18.5% were obese in 1997. Although the percentage of overweight adults continued to hover around 34% in 2017, the percentage of obese adults ominously climbed to 30.4% in just two decades (Blackwell and Villarroel, 2018). With more than 64% of the overall adult population in the overweight or obese category of body mass index (BMI), public health professionals are promoting the importance of regular physical activity and active lifestyles for healthy living. Apart from reducing the negative health consequences of being overweight, regular physical activity has been shown to have direct health benefits in terms of decreasing the risk of cardiovascular disease, diabetes, colon cancer, breast cancer and osteoporosis; additionally, it is likely to have a positive impact on mental health by reducing symptoms of anxiety and depression (U.S. Department of Health and Human Services, 1996; Caspersen et al., 2000).

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), 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).

Any walking episode can 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*. 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.

Although prior research has amply documented determinants and health/environmental consequences of walking, (both utilitarian and recreational), there has been little research on how people feel about walking episodes (trips) from an emotional well-being 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. (2018) 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 emotional feelings. 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.

There are a couple of other reasons why an understanding of emotions is important in the context of walking. The emotional feelings 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 does not place additional time pressure (stress) on the individual *and* also provides health benefits. The complex nature of the relationship between emotions and activity engagement in the context of evolving lifestyles calls for a detailed analysis of well-being associated with different types of walking episodes.

An understanding of the emotional feelings of well-being 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; by understanding 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 more positive emotions, then an increase in walking activity may occur – yielding health and environmental benefits that would not have been realized otherwise. If subjective feelings of well-being are greater (more positive) 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 well-being emotions associated with walking episodes is accomplished in this paper through the use of 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 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 activities are extracted from this database to model the subjective feelings of well-being 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. Concluding remarks are offered in the sixth and final section.

2 RECREATIONAL/UTILITARIAN WALKING AND EMOTIONAL FEELINGS

Studies in the field of transportation and urban planning consider walking as an alternative mode of transportation that is 'greener' than most other modes and offers substantial health and traffic related benefits (helps in reduction of vehicular pollution and traffic congestion). Therefore, transportation and 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.*, Cerin et al., 2007; Cervero et al., 2009; Norman et al., 2013; Doescher et al., 2014; 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 (*e.g.*, Boone-Heinonen et al., 2009; Frank et al., 2008). 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; Trost et al., 2002; Williams et al., 2008). These studies also focus on the environmental correlates that promote recreational walking (*e.g.*, Gomes et al., 2011; Hekler et al., 2012; Kamphuis et al., 2009).

A few discernible patterns emerge from studies relating built environment attributes to the amount of utilitarian and recreational walking. It is generally observed that factors such as neighborhood density, degree of land-use mix, accessibility and proximity to destinations, street connectivity and access to public transport significantly influence utilitarian walk propensity. Recreational walking is influenced by attributes such as presence of dedicated walking facilities (paths/trails), safety and availability of open-spaces, and parks in and around the neighborhood. Interesting socio-demographic differences in utilitarian and recreational walk propensities also have emerged in the literature. For example, Cole et al. (2006) mention that utilitarian walking is more prevalent among men, individuals in lower income households, and unemployed individuals. Similarly, Doescher et al. (2014) find that younger adults, males, and people of non-white race exhibit higher odds of utilitarian walking. On the other hand, Kamphuis et al. (2009) find that lower education level and lower income levels are associated with lower levels of recreational walking. Kruger et al. (2008) presented a detailed demographic analysis of utilitarian and recreational walk propensity based on gender, education level, income level and race among others.

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 (see, for example, 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 (*e.g.*, Wagner et al., 2001; Kruger et al., 2008; Christian et al., 2011; Handy et al., 2006; Saelens and Handy, 2008). Giles-Corti and Donovan (2003) note that complementary strategies that target individual and social environmental factors are essential to promote both utilitarian and recreational walking. In fact, a combination of utilitarian and recreational walking may help in achieving the recommended levels of physical activity among the sedentary population (Giles-Corti and Donovan, 2002). To implement complementary strategies that can positively impact both utilitarian and recreational walking, differences in the built environment and socio-demographic determinants of these two types of walking episodes need to be explicitly recognized.

In spite of the large body of research related to walking, including the mental health considerations, there remains a paucity of research on the emotional well-being associated with different types of walking episodes. The emotional well-being associated with the immediate subjective feelings during a walk episode has not received much (if any) attention from both transportation and public health professionals. 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, sadness, meaningfulness, painfulness, stressfulness, and tiredness. However, sadness and happiness are figuratively and literally perceived as exact opposites (Russell and Carroll, 1999), and hence it is very likely that they would reveal very similar and virtually identical opposing relationships with the covariates (in any modeling effort). Although some have challenged this notion (*e.g.*, Larsen et al., 2001; Larsen et al., 2004), most agree that the bipolarity of happiness and sadness holds under normal circumstances and may only diverge under emotionally intense situations. Therefore, the analysis presented in this paper excludes the sadness emotion, and considers the associations of five other emotions for walk episodes – happiness, meaningfulness, painfulness, stressfulness and tiredness.

The five different emotions 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 present pursuit of valuable goals or positive impact of past achievements (Martela, 2017). Painfulness, on the other hand stems from the 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 fifth 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, there are a number of studies that have emphasized the unique aspects of the different emotions. For example, happiness and meaningfulness both relate to positive emotions; however, there are substantial differences between the realization of the two emotions, which has been emphasized by Metz (2009). Happiness is more of a subjective feeling, whereas meaningfulness is more objective. Also, the state of happiness is generally fleeting whereas meaningfulness is more prolonged. Similar differences have been noted among the other emotions (*e.g.*, Schiffrin and Nelson, 2008; Kovecses, 2008; Keefe et al., 2001), thus suggesting 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 well-being 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 well-being 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. However, as mentioned earlier, this study considers only five emotions after dropping the emotion related to sadness. From the three years of ATUS well-being modules, information for walk-related activity episodes was selected. 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, well-being 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. 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 falling between 20 and 65 years of age. The sample is rather evenly split between males and females. A majority of the records (54%) are reported by employed individuals. 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 9 AM) and another 29% take place in the afternoon hours of 3:30PM to 7:30 PM. A majority of records (53%) do 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.

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%

Variable	Count	%	Variable	Count	%
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 (9.00AM-3:30PM, before 5:00 AM, after 7:30 PM)	710	45%	**Duration**		
Social interaction during walking			Less than 10 minutes	469	30%
Yes	743	47%	10 minutes to 20 minutes	645	40%
No	840	53%	Greater than 20 mins	469	30%
Child(ren) accompanying on Trip					
Yes	215	14%	No	1368	86%

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 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	St. dev.	Mean	St. dev.	Mean	St. dev.
Happiness	4.35	1.62	4.87	1.42	4.50	1.58
Meaningfulness	3.98	2.10	4.94	1.6	4.26	2.01
Painfulness	0.92	1.65	1.02	1.62	0.95	1.64
Stressfulness	1.29	1.72	0.93	1.54	1.19	1.68
Tiredness	2.19	1.95	1.78	1.82	2.07	1.93

Note: Means are based on a measurement scale of 0-6.

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.

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 emotional feelings 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 well-being (emotion) variables for each individual; in the current study, I = 5). Let the number of ordinal levels for the well-being 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 well-being 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×1) vector of exogenous variables (not including a constant), β_i is a corresponding (L×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 well-being 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 well-being 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 well-being variables i for each individual q. Specifically, define $\varepsilon_q = (\varepsilon_{q1}, \varepsilon_{q2}, \varepsilon_{q3}, \ldots, \varepsilon_{qI})'$. 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 $\boldsymbol{\Sigma}$ capture the error covariances among the underlying latent continuous variables of the different well-being variables; that is, they account for the presence of common unobserved factors influencing the intensity outcome for each well-being variable. Thus, if ρ_{12} is positive, it implies that individuals with a higher than average propensity to report high levels for the first well-being variable are also likely to have a higher than average propensity to report high levels for the second well-being variable. If all correlation parameters (*i.e.*, off-diagonal elements of $\boldsymbol{\Sigma}$) stacked into a vertical vector, $\boldsymbol{\Omega}$, are identically zero, the model system in Equation (1) collapses to a series of independent ordered response probit models for each well-being 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 $i = 1, 2, ..., I$. Let the actual observed well-being level for individual q and well-being variable i be m_{qi}. In that case, the likelihood function for individual q may be written as follows:

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

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

$\phi_I(.,.,...)$ 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). Model estimation results are presented in the next section.

5 RESULTS

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 subjective ratings on various emotions. 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 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 emotion for the *recreational episode type*, while the interaction effect captures the *differential* influence of

the 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. 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), contributing to higher levels of pain.

Women generally report higher levels of happiness and lower levels of stress (than 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 Blair 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 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					
Metropolitan region (*base:* Non-metropolitan region)	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

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). 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 well-being from the walking that they do.

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 and structure are also key determinants 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).

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.

Overall, it can be seen that socio-economic and demographic characteristics affect the emotional feelings that people derive from walking episodes. It is also found that socio-demographic market segments exhibit differences in the intensity of emotional feelings for walking episodes of different types, with utilitarian walking episodes generally rated less positively than recreational walking episodes. In other words, it appears that investments that enable recreational walking activities would yield greater overall benefits in well-being, although utilitarian walking infrastructure is important for fulfillment of activities – particularly for those who are mobility-challenged.

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. 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 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.

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. 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).

Finally, the time-of-day indicators have coefficients that suggest that morning recreational walks (relative to the mid-day and periods of night time) 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.

6 CONCLUSIONS

There is a broad awareness of the ills of a sedentary lifestyle and the need to promote active lifestyles in communities across the country. Walking is an active mode of transportation that, if

integrated into an overall lifestyle package, could provide considerable benefits over a sustained period of time. Despite awareness of the benefits of walking, inactive lifestyles and obesity are on the rise. Because the benefits of walking are not immediately experienced or realized, people may not be able to discern the importance of and benefits that accrue from walking. In order to enhance the level of walking among the population, it may be beneficial for transport planners and public health professionals to understand and quantify the more immediate emotional feelings engendered by a walking experience. Such an understanding would allow planners to target specific subgroups for interventions and awareness campaigns and to plan walking-related investments in infrastructure and public places that would bring about the greatest gains in walking. Lack of data about emotional well-being associated with activity engagement has generally precluded the ability to undertake such an analysis. 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 emotional feelings associated with walking episodes.

Walking episodes of two types are defined and considered in this paper; first, walking for recreation (with no clear destination or defined activity purpose) and second, walking for utilitarian reasons (to accomplish an activity at a destination). These are considered separately to better understand differences in how socio-demographic characteristics and walking episode attributes influence feelings of well-being that people derive from the two types of walking episodes. All of the walking episodes in the ATUS data set are classified into one of these two categories. 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. Gender, age, employment, race and ethnicity, and household structure are all key determinants of emotions associated with walking. Women derive greater happiness than men for any walking episode, and derive more meaningfulness too from any walking episode (though women derive much more meaningfulness from recreational episodes relative to utilitarian episodes, to the point that there is no statistically significant difference in meaningfulness between men and women for utilitarian walking). Those who are employed experience positive emotions from walking more so than unemployed individuals, but the meaningfulness drops in the context of utilitarian walks. Those with a higher education attainment experience greater levels of stress and tiredness and lower levels of happiness from walking episodes; and the meaningfulness drops for utilitarian walks for those with a college degree (relative to those who do not), suggesting that utilitarian walks do not offer a restorative benefit or a sense of fulfillment for educated and employed individuals who are likely undertaking such walk episodes for work activities and are under time-pressure. Social accompaniment and presence of children engenders more positive emotions, suggesting that solo walking episodes may

be less inspiring than those that involve a social element. Walks on weekends are viewed more favorably (especially for utilitarian episodes), as are walks in the morning hours (especially for recreational episodes). Overall, it can be seen that utilitarian walks generally engender a lower level of positive emotions when compared with recreational walks, and the displeasure associated with utilitarian walks (relative to for recreational walks) is amplified for certain demographic groups (*e.g.*, women, employed, those with college degree, and Hispanics). On the other hand, those who have physiological limitations derive greater happiness from utilitarian walks relative to recreational walks, as do those walking in metropolitan environments, presumably because of the sense of accomplishment that these walk episodes offer in these particular situations.

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. 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.

The present study makes a novel attempt to model how people feel during walk episodes. To better plan urban and recreational spaces, data on emotional feelings is needed and should be collected as part of future activity-travel and time use surveys. Detailed information about the built environment was lacking in the data set used for this study, and future research should strive to include such secondary land use data in modeling efforts. 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 walking episodes can be disentangled.

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