



Well-being implications of immobility during COVID-19: evidence from a student sample in Bangladesh using the satisfaction with life scale

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Abstract

Immobility is known to impact health and well-being by reducing social contact, activity participation, and changing time use patterns. These unfortunate effects mostly affect specific demographic segments, including older adults, low income families, people who face disabilities, and those living in conflict zones. Emergency measures taken during the COVID-19 pandemic mandated or strongly recommended limitations to mobility, thereby causing this condition for segments of the public not usually characterized by high levels of immobility. In the context of the pandemic, reduced mobility was the non-pharmaceutical intervention of choice, and the evidence suggests that it helped to keep incidences of the disease from exploding. On the other hand, there is also a need to understand how mobility restrictions may have had incidental impacts, including to well-being, in population groups that have not been studied from this perspective before. In this spirit, the present paper uses the items of the Satisfaction with Life Scale to investigate how aspects of well-being changed during the pandemic, using a sample of 400 college and university students in Dhaka, Bangladesh. Analysis is based on multivariate ordered models and the results suggest that being less mobile, less active, and changes in activity time use due COVID-19 had an impact on the satisfaction with life of students. The detrimental effect was more marked for males and students from low-income households. Additionally, perceptions of residential characteristics and sense of belonging also correlate with satisfaction with life in the period under study.

Keywords Immobility · Well-being · COVID-19 · Bangladesh · Multivariate ordinal model

Mathematics Subject Classification MSC code 1 · MSC code 2

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Introduction

The issue of immobility is a concern for transportation professionals, since it speaks to the ability of the public to move, and the ability of the transportation systems to satisfy the need for movement (Madre et al. 2007; Hubert et al. 2008; Bayart et al. 2018; Motte-Baumvol and Bonin 2018). Immobility is a condition that has been identified in the past in transportation research, but mainly for some specific segments of the population. This includes people in their later years (e.g., Tacken 1998; Roorda et al. 2010; Sikder and Pinjari 2012), members of families with low incomes (e.g., Roorda et al. 2010; Hine et al. 2012; Motte-Baumvol and Nassi 2012), people who face disabilities (e.g., Farber and Páez 2010; A. Paez and Farber 2012), and people who live in conflict zones (e.g., Harker 2009; Aouragh 2011).

The implications of immobility have been studied perhaps for no other group more than for older adults (for example, Ziegler and Schwanen 2011; Nordbakke and Schwanen 2014; Asp et al. 2017; Pantelaki et al. 2021). Previous research has explored the implications of immobility for physical and mental health, given how it impacts older adults' social contact (Prem et al. 2017; Kemperman et al. 2019), activity participation (Shergold 2019), and time use (M. Li and Tilahun 2017; Enam et al. 2018). However, there are reasons to believe that immobility, albeit less common, might still impact other demographic segments as well. At the very least, mobility has been found to associate with higher life satisfaction (e.g., Morris 2015), which suggests that its *absence* may have the opposite effect. In the context of COVID-19, the pandemic led to a situation where the "rules and norms of mobilities previously taken for granted were re-negotiated and re-defined" (Freudental-Pedersen and Kesselring 2021).

The public health emergency triggered by COVID-19 resulted in extended periods of high levels of immobility in many regions in the world. Initially, the absence of pharmaceutical approaches to treat the novel virus, meant that social distancing and (mandatory or recommended) self-isolation were the earlier public policy tools of choice. These policies led to significant declines in movement (DeWeese et al. 2020; Molloy et al. 2020; Astroza et al. 2020; Saha et al. 2020), and increased the levels of immobility for all age and demographics groups at a scale without parallel in recent memory. Older adults who already experienced low mobility in the pre-pandemic period had to cut down their mobility even more and keep distance from others during the pandemic as they were more vulnerable to the COVID-19 (Shaer and Haghshenas 2021; Choe et al. 2022; Q. Liu et al. 2021a).

While lower mobility was seen as a necessity to slow the spread of the virus that causes COVID-19 (see Auger et al. 2020; Antonio Paez et al. 2020; Antonio Paez 2020; Singh and Adhikari 2020), it behooves us to study the incidental impacts of higher levels of (suggested or mandated) immobility among population segments for whom this condition has never been as prevalent as for older adults. In particular, the mental health impacts of school closures and public health restrictions on mobility and resulting social isolation during COVID-19 remain a yawning gap in research (J. Lee 2020; Asanov et al. 2021) with so far only few efforts to understand them (see Zuev and Hannam 2021; Conrad et al. 2021). It should be noted that the immobility due to COVID-19 differs in a key respect from other forms of immobility, in that it also has an important pro-social component, which may help to alleviate some of its negative impacts.

Like other sectors, institutions of higher education around the world faced disruptive closures which led to substantial changes in lifestyle patterns during COVID-19, including changes in activity time-use or time allocation. Among students, in particular, the impacts

were felt in work schedules (Asanov et al. 2021), physical activity (Kovacs et al. 2022; Luciano et al. 2021; Bertrand et al. 2021), online activities (Kovacs et al. 2022), sedentary behavior (Luciano et al. 2021), sleep (Luciano et al. 2021; Bertrand et al. 2021), study (Asanov et al. 2021) and leisure (Asanov et al. 2021). Immobility during COVID-19 also caused challenges to meet the recommended level of physical activity and sleep levels among students (Luciano et al. 2021). The relationship between the changes in time use for different activities caused by immobility and mental well-being can provide us new insights on student well-being caused by COVID-19.

In the case of Bangladesh, all educational institutes were closed in Bangladesh for in-person classes for the entire period of the first wave of the pandemic. Along with health and economic impacts, unprecedented changes in day to day lifestyle and activity participation may have affected well-being. This is concerning since some studies indicate that the psychological impact may last longer than other impacts (Armour et al. 2020; Wang et al. 2020).

The objective of this paper is to investigate the changes in subjective well-being (SWB) during the pandemic among university and college students of Dhaka, Bangladesh. More to the point, we are interested in the influence on well-being of socio-demographic characteristics, changes in activity-time use, perception of residential location, social life, and sense of belonging. Along with changes in activity time use, these attributes have been found to influence well-being in various regions in the world (Gidlöf-Gunnarsson and Öhrström 2007; Xinyu Jason Cao 2016; Zhang and Zhang 2017; Zhou et al. 2021). Studies have also found that individuals' social life, social network, intensity of social connections, and sense of belonging significantly impact individuals' life satisfaction (Chow 2007; Zhang and Zhang 2017; Amati et al. 2018; Ahn and Davis 2020). Our research is based on a sample of $n = 400$ university and college students in Dhaka, Bangladesh who responded to a survey entitled "Exploring the Impact on Well-being caused by COVID-19". The survey used the Satisfaction with Life Scale [SWL; Pavot and Diener (2008)] and asked respondents to rate the items in the scale for the periods before and during the pandemic. In addition, the survey asked about time use patterns, perceptions of residential location, social life and sense of belonging, and socio-demographic information.

Multivariate ordinal models are used to account for the correlations among items in the SWL. The results of our study suggest that loss of mobility, reduced levels of activity, and changes in time use for different activities due to COVID-19 had an impact on the well-being of students. The detrimental effect was more marked for males, and students from low-income households. Additionally, perceptions of residential characteristics and sense of belonging also correlated with well-being. This paper makes several contributions to the literature. First, it analyzes changes in well-being from the lens of time use-activity participation during the pandemic. Second, it provides evidence of the impact of immobility on well-being in the context of a developing country. Third, it focuses on the well-being of a vulnerable group, young adults and students who have been greatly affected by school closures, leaving them vulnerable to mental distress and loss of well-being. And finally, it adds to the ongoing debates regarding use of scale to measure well-being by showing that even different factors can influence different indicators/items/components of a specific measurement scale differently.

Background

Subjective well-being was proposed by Kahneman (1999) as an alternative to utilitarian perspectives in economics. Previous research has identified personal characteristics that influence well-being. For example, income is positively related to SWB (Ferrer-i-Carbonell 2005; Bergstad et al. 2012). Age has a U-shaped relationship with SWB—SWB has been found to be lowest at age 40 before gradually increasing as people grow older (Diener and Suh 1997; Bergstad et al. 2012). It has also been found that marriage (Diener et al. 1999), living with a spouse, and higher levels of education (Bergstad et al. 2012) increase SWB. On the other hand, divorce (Diener et al. 1999), death of a partner (Diener et al. 1999) and unemployment (Bergstad et al. 2012) decrease SWB. Numerous studies have explored subjective well-being and quality of life in terms of available opportunities, social connections, geographic location, neighborhood level built-environment characteristics, and personal and household characteristics. As a result, a body of knowledge has emerged to suggest that these factors impact well-being or quality of life to various extent (e.g., Ballas 2013; Okulicz-Kozaryn 2015; Moore et al. 2018; Kwon et al. 2019; Cuignet et al. 2020).

The concept of SWB has been enthusiastically embraced in the field of transportation as a way to understand mobility from a non-utilitarian perspective (Ettema et al. 2010). Mobility is essential for social integration, and has been found to associate with life satisfaction and well-being. Traveling and how we travel affect our mood, which in turn impact subjectively experienced well-being (Ettema et al. 2010). There is a relationship between transportation options, activity engagement, and lifestyle preferences, which implies that changes in said options can affect SWB (Ettema et al. 2010). Studies by Delbosc (2012), Vos et al. (2013), and Mokhtarian (2019) discuss different ways in which SWB can be influenced by travel and associated factors. Delbosc (2012) explored the role of well-being on transport policy and mentioned three factors of transport systems that can influence SWB: access to important activities, physical mobility, and physical infrastructure. According to Delbosc (2012), how transport infrastructure supports individuals in accessing their jobs, maintaining social relationships and how it meets their diverse mobility needs resulting from aging, disability, and poverty can impact well-being. Also, access to services and infrastructure such as active travel facilities (e.g. connected bike network, sidewalks), transit and subsidized transport options may provide psychological benefits by encouraging sense of freedom, self-efficacy, and confidence (Delbosc 2012; Mokhtarian 2019). How transport and land use interact with each other can also impact SWB. For example, transport and land use policies can facilitate activity participation and active travel, which can impact SWB (Delbosc 2012). Other studies (e.g., Vos et al. 2013; Archer et al. 2013; Schwanen and Wang 2014; Birenboim 2018) have also explored how activity time use and travel pattern influence well-being.

Although not completely related to the current study, satisfaction with travel is another domain in travel-related studies that relates to SWB. Travel satisfaction can be domain-specific life satisfaction and can refer to both in general satisfaction with travel and/or satisfaction with a specific trip, and/or transport mode (Ettema et al. 2011; Vos et al. 2016; De Vos and Witlox 2017; Vos and Jonas. 2019). There is another domain of travel and SWB studies which focuses on the interactions of residential self-selection, satisfaction with travel and SWB (e.g., Xinyu“ Jason” Cao and Ettema 2014; Vos and Jonas, and Frank Witlox. 2016; Ettema and Nieuwenhuis 2017).

SWB has been of great interest due to its potential to become a powerful policy tool, with some claiming that the primary aim of urban and transport policies should be to

increase individuals' well-being (Diener 2006; Ettema et al. 2010; Kahn et al. 2002). The policy usefulness of SWB, however, depends on the ability of researchers to establish robust connections to various policy domains (Reardon and Abdallah 2013). For this reason, despite a flurry of research in the past decade or so, there remains a need to explore SWB from the perspective of transportation (Mokhtarian 2019). It is from this perspective that the response to COVID-19 highlights the link between well-being and quality of life: by asking from the public unprecedented restraint in mobility, COVID-19 exposed to immobility large segments of the public not usually affected by it, including children and young adults, two population groups that are vulnerable to anxiety and depressive symptoms (Orgilés et al. 2020).

Among the factors exacerbated by the pandemic that might affect well-being, we count concerns about health regulations, the perceived risk of virus transmission, the need for physical distancing and self-isolation, and overstretched health care capabilities, as well as the closure of educational facilities, the fear of job losses and exposure to precarious financial conditions (Armour et al. 2020; Kecojevic et al. 2020; Maugeri et al. 2020; Paredes et al. 2020).

In this context, several factors have already been found to affect well-being. Being female (Wang et al. 2020; Kai et al. 2020), living in rural areas, being in contact with COVID-19-positive patients (Kai et al. 2020), student status, the presence of health conditions and poor self-rated health (Wang et al. 2020) have all been found to correlate negatively with well-being. College students in China were found to be more likely to experience stress, anxiety, and depression than others during the pandemic (S. Li et al. 2020). W. Cao et al. (2020) found that the anxiety levels of college students during lockdown tended to be lower if they lived in urban areas, their family's economic condition was stable, and they lived with their parents. On the other hand, economic instability and slowdown of academic activities due to COVID-19 were highly likely to increase anxiety related symptoms (Alvarez et al. 2020). Another study by Liu et al. (2021a, 2021b) found that social isolation and remote communication had an adverse affect on students' well-being. Ongoing studies explore changes in lifestyle due to COVID-19 and how they impact mental health and well-being (e.g., Tan et al. 2020 in Australia). It is worth noting that each of the studies used different psychological and/or well-being scales, which complicates any efforts to reach more general conclusions (Reardon and Abdallah 2013; Mokhtarian 2019; Firth et al. 2020). Furthermore, besides the ethnographic study of Zuev and Hannam in Macau (2021), we are not aware of other research into the issue of subjective well-being during the pandemic from the lens of immobility.

Context, data, and methods

Context

Bangladesh is a South Asian country of about 160 million people experiencing rapid economic development and urbanization. Dhaka, the capital city, currently has a population of approximately 20 million, with an average population density of 46,000 per square kilometer (Bangladesh Bureau of Statistics 2015). Following discovery of the first COVID-19 case in Bangladesh on March 8, 2020 (Star 2020), a complete lockdown strategy was adopted on March 26, 2020 to enforce physical distancing and limit the transmission of the virus among the population. There were substantial reductions in overall mobility (see

Jamal and Paez 2020) in this period, however, 66-days after the original order to shelter in place the orders were relaxed to mitigate the impacts to economy and livelihoods. All education institutions of the country were closed until the mid of June 2020 and then, educational institutions were asked to conduct their classes online (Bangladesh 2020). During the survey period of this study, colleges and universities were running primarily online.

Data

The data used for this study consist of a sample of 400 college and university students who live and study in Dhaka, Bangladesh. It is to be noted that the post secondary education system in Bangladesh is quite different from those of the developed countries. We did not find reliable data indicating the total number of colleges and their student populations in Dhaka. However, on a relevant note, there are 3,196 colleges in Bangladesh providing post secondary education—most of them operate under Bangladesh's National University (Trines 2019). Aside from this, there are 44 public university and 103 private universities in Bangladesh among which 9 public and 54 private universities are situated in Dhaka (Trines 2019; "Universities in Dhaka," n.d.). Also, there are technical and vocational training colleges and *Madrassa* (religious education institutes which offer elementary-to-post-secondary education in Arabic) (Trines 2019). Due to lack of data, we cannot exactly state the total number of college and university students in Dhaka nor their socio-economic characteristics. But country level statistics reveal that there are 3.2 million students enrolled in post secondary level education in Bangladesh (Mannan 2017).

An online survey titled 'Impact of COVID-19 on the well-being of the College and University Students' was conducted from May to August, 2020. The survey was conducted to explore the possible effect of changes in day-to-day activities and lifestyle on the well-being of students in institutions of higher education in Dhaka. Google Forms was used to distribute the questionnaire among students. The survey was disseminated to potential respondents using social media, for example, Facebook advertisement, and contacting the admins of college and university student groups in Dhaka. Additionally, the survey link and other necessary information were emailed to different colleges and universities in Dhaka with a request to distribute. All universities were emailed but only 8 colleges had a website with contact information. Colleges and universities in Dhaka do not, with the exception of a few private universities, provide institutional emails for their students, so their main way of communication is notice boards. We mostly relied on advertising on social media as institutions were closed. The inclusion criteria for the survey were that participants had to be university or college students, attending an educational institute in Dhaka, and currently residing in Dhaka. Participants had to confirm these selection criteria before starting the questionnaire. Similar to many other surveys conducted during the pandemic (e.g., Astroza et al. 2020; Dong et al. 2020; Dunton et al. 2020; Van de Velde et al. 2021; White and Van Der Boor 2020), we work with a convenience sample, and limited to people with internet access.

The survey was divided into 5 sections. In the first section, the respondents were asked about their ideal time use, that is, the amount of time they would ideally like to spend for daily activities including sleep, study, work, commute and other travel, household work and family care, etc. This section was developed based on the review of different time use surveys both before and during COVID-19 period [e.g., please see the study by Hamermesh et al. (2005); Brint and Cantwell (2010); Gershuny (2011); Asanov et al. (2021); Bu et al. (2021); for reference of the time use surveys]. In the second section of the survey,

the respondents were asked to report the amount of time they typically spent on each of the same activities during COVID-19. They were also asked to report their responses on items on the Satisfaction with Life Scale before and during COVID-19 lockdowns. In the third section, respondents were asked to report the time they used to spend on daily activities before COVID-19. The fourth part of the survey consisted of 38 attitudinal questions on a 5-point Likert scale ranging from *Strongly Disagree* to *Strongly Agree*. These statements aimed to capture the lifestyle, social life, sense of belonging, and perceptions of the place of residence in Dhaka of respondents. Along with exploring previous surveys of lifestyle, social life and perceived residential location related studies, we explored COVID-19 related ongoing transportation and mental well-being surveys available online during the first wave of the pandemic which started before May 2020. Through a comprehensive review of the survey questionnaires and our own assessment of their applicability in the context of Dhaka's college and university students we developed 15 lifestyle related attitudinal statements [see White and Van Der Boor (2020); Asanov et al. (2021); Van de Velde et al. (2021); Cervera-Martínez et al. (2021); Balanza-Martínez et al. (2021); Boutebal et al. (2021); for the statements and relevant findings], 10 social life and sense of belonging related statements [see Saiz et al. (2021); Gopalan et al. (2022); The Ohio State University (2021); Boutebal et al. (2021); Okabe-Miyamoto and Lyubomirsky (2021); McCallum et al. (2021); for the statements and relevant findings] and 13 perceived residential location related questions [see Tu and Lin (2008); Strongegger et al. (2010); Permentier et al. (2011); Giles-Corti et al. (2013); Kyttä et al. (2013); Sugiyama et al. (2014); He and Thøgersen (2017); Zhang and Zhang (2017); for the statements and relevant findings] were asked. In the final section, students were asked to report their socio-demographic characteristics such as age, gender, household income, personal source of income, living arrangements, and usual mode of transportation.

Satisfaction with life scale

For this study, we adopted the Satisfaction with Life Scale [SWL; Pavot and Diener (2008)] to measure the well-being during lockdown among the students. This scale consists of 5-items designed to measure global cognitive judgments of life satisfaction. The items of the scale are as follows:

- In most ways my life is close to my ideal (hereafter “Life close to ideal”).
- The conditions of my life are excellent (hereafter “Conditions excellent”).
- I am satisfied with my life (hereafter “Satisfied with life”).
- So far I have gotten the important things I want in life (hereafter “Got important things”).
- If I could live my life over, I would change almost nothing (hereafter “Change nothing”).

Respondents were required to answer each item on a 7-point Likert scale, ranging from *Strongly Disagree* to *Strongly Agree* with a neutral point. A common practice is to calculate an overall score as the sum of the various items, however, this practice is problematic for multivariate analysis because it confounds several items. For example, those reporting ‘Strongly Disagree’ on an item are given 1 point for that item. The highest point for each item is 7, which is given if the respondent answers ‘Strongly Agree’. The sum of ordinal variables is acceptable for the purpose of univariate ranking, but less so in multivariate

analysis since the mean and standard deviation are not defined for ordinal variables. For this reason, in this study we forego the composite value of the scale, and estimate instead separate models for each of the individual items by utilizing multivariate regression.

Furthermore, we are interested in the *change* in responses from before to during COVID-19. The difference of two ratio/interval variables is itself a ratio/interval variable; similarly, the difference of two ordinal variables is another ordinal variable. For the analysis that follows, the dependent variables are coded as the shifts (in steps) in response to each item in the SWL Scale, from “before” to “during” COVID-19. To calculate the steps difference, we note that the SWL Scale consists of 7 values. Therefore the range of the shifts is -6 steps (if a respondent shifts from *Strongly Agree* to *Strongly Disagree*) to +6 steps (if a respondent shifts from *Strongly Disagree* to *Strongly Agree*). By defining the dependent variables as ordinal shifts in steps, we can study how change in time spent in different activities due to COVID-19, socio-demographic characteristics, perceived residential characteristics, sense of belonging, and lifestyle preferences impacted each of the items during COVID-19 and how each item is related to each other. We submit that this approach avoids unseemly confounding the various items in the SWL, and offers more in-depth insights about how consistently various factors correlate with different items of the satisfaction with life scale. Although there is a possibility that the time of the survey has an effect on the well-being of students, the number of days between the lockdown (March 26, 2020) and the day survey was completed by the respondent was not a significant variable in any of the five models. Therefore, this variable was excluded from the analysis.

Methods

Presently, we have two ordinal variables for each item in the SWL Scale, namely the responses for the periods before and during the lockdowns (Y_b and Y_d respectively). Further, these responses are in 7-point Likert scale (i.e., $k = 1, \dots, 7$) with $k = 1$ corresponding to *Strongly Disagree* and $k = 7$ to *Strongly Agree* (the neutral point is $k = 4$). The shift in the responses from before the pandemic to the time during lockdowns for each statement are our dependent variable, which are define as follows:

$$\Delta Y = Y_d - Y_b$$

This gives a new ordinal variable:

$$\Delta Y = \begin{cases} -6 \text{ steps} & \text{if } Y_d - Y_b = -6 \\ \vdots & \\ 0 \text{ steps} & \text{if } Y_d - Y_b = 0 \\ \vdots & \\ +6 \text{ steps} & \text{if } Y_d - Y_b = 6 \end{cases}$$

We modeled the shifts in 5 items of of SWL scale by following a multivariate (or seemingly unrelated equations) modeling approach. In this approach, multiple outcomes y_q ($q = 1, \dots, Q$) are modeled simultaneously (in this study $q = 5$). The General Multivariate Linear Model is defined as:

$$y = \alpha + \Gamma x + \zeta$$

To see see the model formulation more clearly, the shifts in the 5 items of the models can defined as:

$$\begin{pmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \\ y_5 \end{pmatrix} = \begin{pmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \\ \alpha_5 \end{pmatrix} + \begin{pmatrix} \gamma_1 \\ \gamma_2 \\ \gamma_3 \\ \gamma_4 \\ \gamma_5 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{pmatrix} + \begin{pmatrix} \zeta_1 \\ \zeta_2 \\ \zeta_3 \\ \zeta_4 \\ \zeta_5 \end{pmatrix}$$

where design matrices x_1, \dots, x_5 may or may not have variables in common. In multivariate models, Γ is known as the structural parameter and explains how exogenous variables are related to endogenous variable, α is the vector of intercepts of the 5 outcomes and ζ is the vectors of the residuals of the outcomes. The equations are related by a common variance-covariance structure. If ζ are the stacked residuals of the set of equations, then:

$$E[\zeta\zeta'] = \begin{pmatrix} \psi_{11} & \cdot & \cdot & \cdot & \cdot \\ \psi_{21} & \psi_{22} & \cdot & \cdot & \cdot \\ \psi_{31} & \psi_{32} & \psi_{33} & \cdot & \cdot \\ \psi_{41} & \psi_{42} & \psi_{43} & \psi_{44} & \cdot \\ \psi_{51} & \psi_{52} & \psi_{53} & \psi_{54} & \psi_{55} \end{pmatrix}$$

The variance-covariance parameters are estimable. Obviously, if $\psi_{ij} = 0$ for all $i \neq j$ this would indicate that the equations are independent. For this research, we used the R package {lavaan} (Rosseel 2012) for estimation.

Analysis and results

Descriptive statistics

In this section, we present the descriptive statistics of the sample. We begin with the dependent variables. Figure 1 shows the pattern of shifts in the responses for each item in the SWL Scale through five Sankey diagrams.

Figure 2 shows the frequency of positive and negative shifts for each item in the SWL Scale. We see that the mode of the distribution is zero for every variable (0 steps: no change during the pandemic), with between ~30% and ~45% of respondents had no change in their attitudes towards the SWL statements. This means that in every SWL item, a majority of respondents reported a change. Further, we notice that the pattern of shifts is skewed downward (Fig. 1) or towards left (Fig. 2), meaning that the shift tended to be worse for most of the respondents who reported a change. Keeping in mind that $n = 400$, 187 respondents reported a negative shift for “Life close to ideal” and only 72 reported a positive shift (Fig. 2). This is similar for the rest of the dependent variables: “Conditions excellent” had 203 negative shifts and 70 positive shifts; “Satisfied with life” had 172 negative shifts and 84 positive shifts; “Got important things” had 147 negative shifts and 91 positive shifts; and finally, “Change nothing” had 141 negative shifts and 76 positive shifts. One may speculate that “Got important things” and “Change nothing” reflect longer term perspectives on life, and therefore are less affected by temporal tribulations.

We consider possible independent variables in three broad categories. First, we have socio-economic and demographic variables (see Table 1). The sample tends to be younger as would be expected from data collected from students in institutions of higher education. There are more males in the sample (55%), and this reflects to some extent the challenges of collecting data in a culture where females tend to be wary of sharing information,

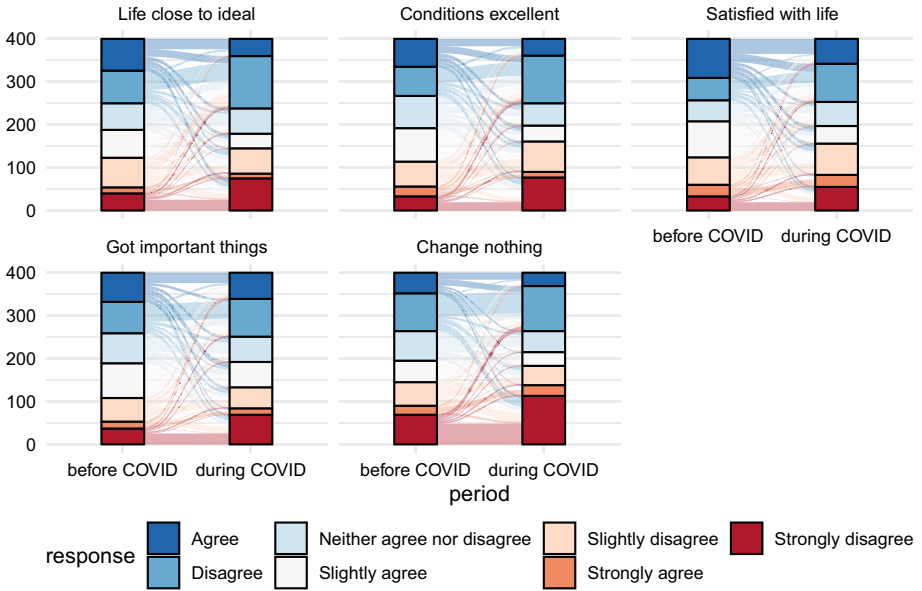


Fig. 1 Sankey diagram showing shifts in SWL from before COVID-19 to during lockdowns

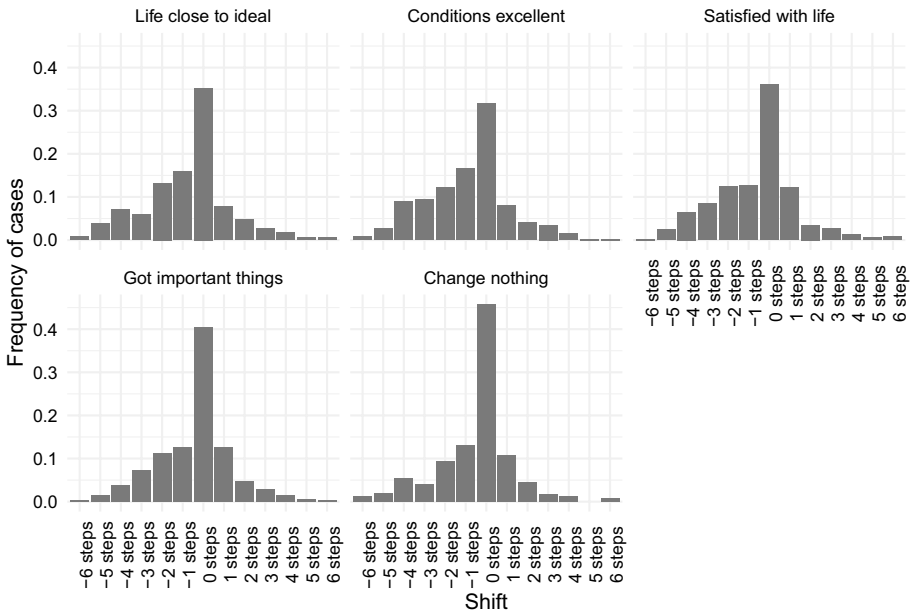


Fig. 2 Bar charts showing shifts in SWL in steps difference from before COVID-19 to during lockdowns

Table 1 Descriptive statistics of socio-economic and demographic variables

Variable	Statistics
Age (in decades)	Min = 1.5, Median = 2.2, Mean = 2.28, Max = 4.4
Sex	Female = 180, Male = 220
Income	High Income = 59, Less than avg = 268
Usual mode of travel	Car = 40, Bus = 129, Rickshaw = 109, Active travel = 82

as discussed by Jamal et al. (2020) and Jamal and Paez (2020). That said, administration of the survey online seems to mitigate the burden of response on women (compared to the sex ratio of 85% in Jamal et al. 2020). About 14.75% of students in the sample are in high income households (in the top quartile), whereas 67% of respondents are members of households with incomes below average. Respondents use a variety of modes of transportation, with bus being the most commonly reported mode and car the least.

The second category of independent variables concerns time use. We consider time use patterns before the pandemic as a baseline (Table 2) and changes in time use during the lockdown (Table 3). These variables are in minutes. As seen in Table 2, with the exception of time sleeping and spent on site at school or in the workplace, the rest of the variables have long right-hand tails. Median time spent studying is 2 h, median time online for studies is 1 h, and median time spent working is 1 h. Compare to the five hours median time spent on site at school or workplaces. Regarding changes to time use during lockdown (Table 3), it is interesting to notice that there was an increase in median sleep time of 1 h 45 min, and about one hour reductions in time spent on studying and working. It is

Table 2 Descriptive statistics of time use by activity before COVID-19 (time in minutes)















Variable	Median	Mean	Distribution
Sleep (before)	360	388.72	
Study (before)	120	137.06	
Work (before)	60	129.30	
Travel by road (before)	120	115.42	
Time at school/workplace (before)	300	264.60	
Out-of-home excluding school/work (before)	90	119.44	
Household work/Family care (before)	60	72.97	
Personal care (before)	30	45.23	
Internet/computer for studying (before)	60	84.41	
Internet/computer except for studying (before)	120	136.65	
Face to face interaction (before)	60	114.86	
Online interaction (before)	60	104.51	
Outdoors activities (before)	15	34.95	
Indoor entertainment (before)	60	88.31	

Table 3 Descriptive statistics of time use changes by activity during COVID-19 (time in minutes)

Variable	Median	Mean	Distribution
Sleep (difference)	105	97.72	
Study (difference)	-45	-53.14	
Work (difference)	0	-71.51	
Travel by road (difference)	-90	-95.55	
Time at school/workplace (difference)	-240	-234.60	
Out-of-home excluding school/work (difference)	-60	-90.86	
Household work/Family care (difference)	60	96.38	
Personal care (difference)	15	38.10	
Internet/computer for studying (difference)	0	21.00	
Internet/computer except for studying (difference)	60	95.66	
Face to face interaction (difference)	-45	-78.38	
Online interaction (difference)	30	55.99	
Outdoor activities (difference)	0	-21.60	
Indoor entertainment (difference)	45	62.02	

to be noted that the survey collected the time spent in school and workplace together, not separately. Time spent traveling declined, as would be expected, with an average reduction of 1 h 35 m from a baseline of almost two hours. The biggest change in time use was the time spent on site at school or workplaces, which declined by almost 4 h from a baseline of 4 h 25 min. There were also reductions in time spent out of home excluding work/school, time spent socializing face-to-face, and conducting outdoor activities. In contrast, there were increases in time spent doing household work and caring for family members, internet usage (both for studying and for other purposes), and social interactions online.

The third category of independent variables is a set of attitudinal statements in three classes: perceptions of the residential environment (Table 4), attitudes about social life/belonging (Table 5), and lifestyle (Table 6).

Since the work of Kitamura et al. (1997), which hinted at the explanatory power of attitudes over land use types (e.g., mixed land use), there has been much interest in the transportation literature in attitudinal variables (e.g., V. Van Van Acker et al. 2011; A. Paez 2013; Veronique Acker et al. 2014; Vos et al. 2018; Wee et al. 2019). Table 4 presents the distribution of responses (using a 3-point Likert scale) to attitudinal statements that refer to the residential environment. There, we see that a majority or plurality of respondents agree that their place of residence is affordable and close to shops and services. In addition, they agree that it has a sense of community with low crime rates and traffic accidents, and that it is safe for children to play outdoors. Most respondents agree that the transportation options available in their neighborhood meet their expectations. On the other hand, a majority or plurality of respondents disagree that they live close to school and/or to parks and open space. As well, pluralities of respondents disagree that traffic congestion is low and that there are considerable amounts of interactions among neighbors.

Next, looking at Table 5, it is clear that respondents tend to have positive outlooks with respect to their social life and sense of belonging. A majority or plurality of respondents agree that they have important things to contribute to society, have feelings of belonging,

Table 4 Descriptive statistics of attitudinal variables; perceptions of residential environment

Variables	Description	Label	Responses			Bar chart
			Disagree	Neutral	Agree	
	The place where I live is very much affordable to me/my family	Shelter affordable	71	69	260	
	I live close to my university/college	Close to university	227	41	132	
	The residence is close to parks or open space	Close to parks	193	53	154	
	The residence is close to necessary shops and services	Neighborhood shops	58	33	309	
	The place where I live has a sense of community/ sense of belonging	Belonging	92	99	209	
	The crime rate in the area/ neighborhood is very low	Low crime	88	88	224	
	The neighborhood is safe for children to play outdoors	Neighborhood safe for children	126	83	191	
	The rate of traffic accidents in the area/neighborhood is very low	Low traffic accidents	102	75	223	
	Traffic congestion is reasonably less in the streets of the area/ neighborhood	Less traffic	179	79	142	
	The transportation options available in my neighborhood meet my expectations	Transportation meets expectations	109	70	221	
	There are lots of interactions among the neighbors in my neighborhood	Interactions	154	112	134	
	I love to being at home with my family	Love being home	52	54	294	

Table 5 Descriptive statistics of attitudinal variables: social life and sense of belonging

Variables Description	Label	Responses				Bar chart
		Disagree	Neutral	Agree		
I feel that I have something important to contribute to the society	I contribute to society	43	45	312		
I feel that I belong to a community (like a social group, or your neighborhood)	Belong to community	48	59	293		
I feel that our society is a good place, or is becoming a better place, for all people	Society good place	148	105	147		
The way our society works makes sense to me	Society makes sense	196	105	99		
I have warm and trusting relationships with family and friends	Warm and trusting relationships	49	57	294		
I feel that my family and friends are supportive of me	Friends and family are supportive	49	59	292		
I love to socialize with people	Love socializing	67	80	253		
I am confident to think or express my own ideas and opinions	Confident expressing opinions	72	86	242		
I am good at managing the responsibilities of my daily life	Responsibility	64	85	251		
I am happy with my social life	Happy with social life	71	107	222		

Table 6 Descriptive statistics of attitudinal variables: lifestyle

Variables	Description	Label	Responses			Bar chart
			Disagree	Neutral	Agree	
	Travel to work/university/college makes me feel stressed	Stress in travel to work/school	176	77	147	
	I prefer work/study from home rather than going to the university/college/office	Working home	251	45	104	
	I prefer performing online activities (e.g. online shopping, online banking, etc.) rather than going to the location	Prefer online shopping/services	190	63	147	
	I often go to cafés/ restaurants for socializing	Socialize in cafés/restaurants	115	57	228	
	I prefer online socializing rather than meeting people face to face	Online socializing	254	62	84	
	My main source of recreation is indoor activities (e.g. computer gaming, reading books, listening music)	Main recreation: indoor activities	122	76	202	
	I perform physical exercise daily	Perform PA daily	178	73	149	
	I consider walking as a part of my daily exercise	Walk as exercise	85	58	257	
	I often go to natural places (e.g. parks, open spaces)	Often visit open spaces	107	66	227	
	I often go to places related to history, culture and heritage	Often visit historical places	136	93	171	
	I enjoy being outdoors	Enjoy outdoors	57	49	294	
	I often play seasonal sports like football, cricket, badminton, table tennis, etc	Play seasonal outdoor sports	173	56	171	
	Me and my family can meet our basic needs (e.g., food, shelter) without any issue	Can meet basic needs	54	49	297	
	I am happy with my financial condition	Happy with financial situation	108	79	213	
	I am satisfied with my overall condition of physical health	Satisfied with physical health	116	71	213	

as well as warm, trusting, and supportive relationships with family and friends. Most respondents report a love of socializing, good skills to manage responsibilities, and happiness with their social life. Almost equal numbers of respondents disagree and agree that society is a good place (148 to 147), but only a minority agree that the way society works make sense to them (99).

Finally, Table 6 presents the distribution of responses to lifestyle statements. It is interesting to note that a plurality of respondents do not report feelings of stress when traveling to work/school; related to this, only minorities report a preference to work/study from home or a preference for shopping and completing other chores online. Most respondents prefer to socialize in public venues such as restaurants and cafés, while few prefer online socializing, even as a slim majority of respondents conduct a majority of their recreational activities indoors. A plurality of respondents report conducting daily physical activity (a majority do not), but most agree that walking is part of their daily exercise. Most students are happy with their physical health. In terms of places to visit, a majority of students report often going to natural places, a plurality to historical locations. Most students report enjoying spending time outdoors, and almost as many as not report playing seasonal sports. Concerning finances, a majority of students agree that they and their families can meet their basic needs without issues and report feeling happy with their financial conditions.

Multivariate model: results

As discussed previously, there are five items in the SWL Scale (Pavot and Diener 2008). Shifts in the responses for each item were modeled using multivariate regression. The

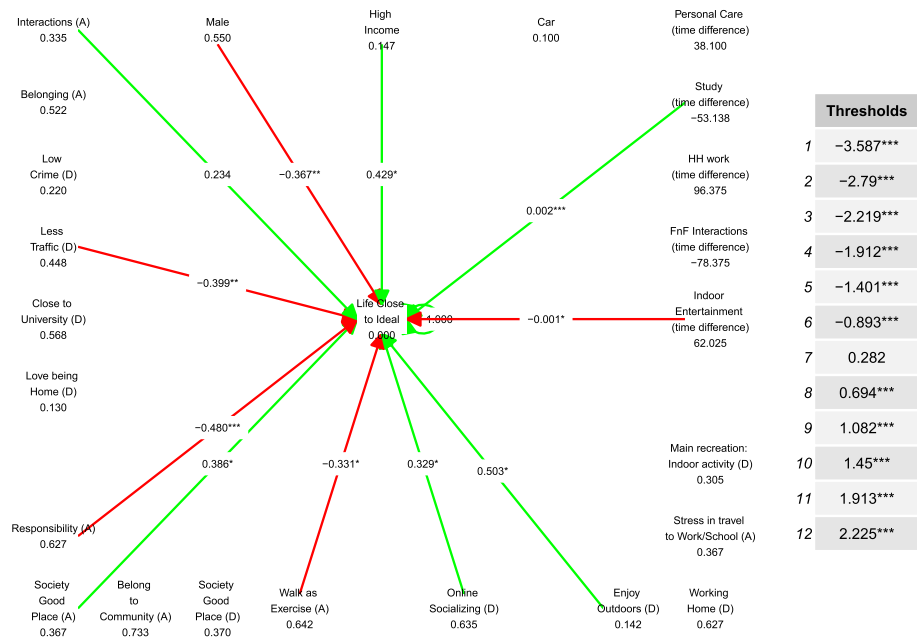


Fig. 3 Multivariate ordinal model of the shifts: item “Close to Ideal” (red arrows are negative effects; green arrows are positive effects; in attitudinal factors (A) means agree and (D) means disagree; the numbers under the independent variables are the corresponding sample means)

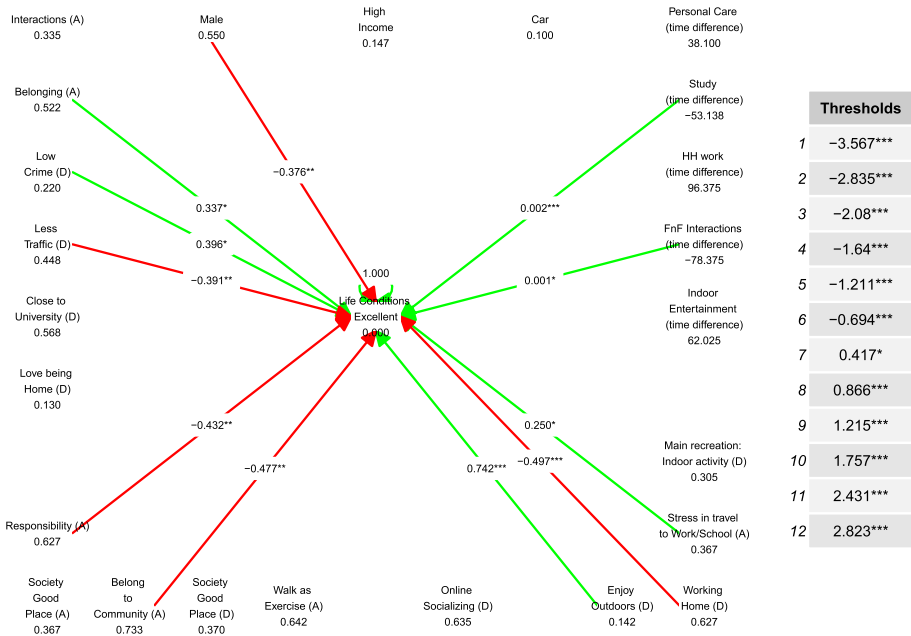


Fig. 4 Multivariate ordinal model of the shifts: item “Life Conditions Excellent” (red arrows are negative effects; green arrows are positive effects; in attitudinal factors (A) means agree and (D) means disagree; the numbers under the independent variables are the corresponding sample means)

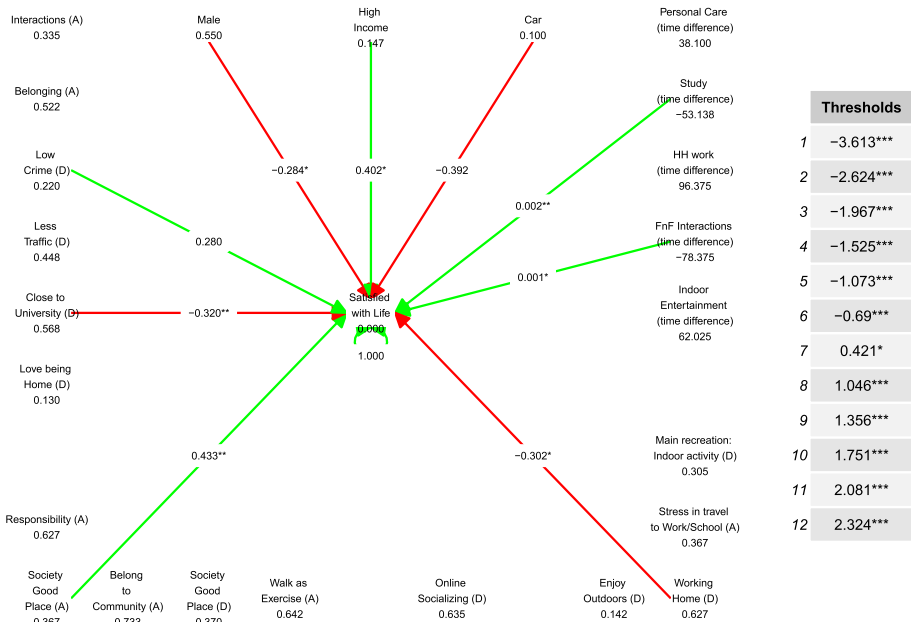


Fig. 5 Multivariate ordinal model of the shifts: item “Satisfied with Life” (red arrows are negative effects; green arrows are positive effects; in attitudinal factors (A) means agree and (D) means disagree; the numbers under the independent variables are the corresponding sample means)

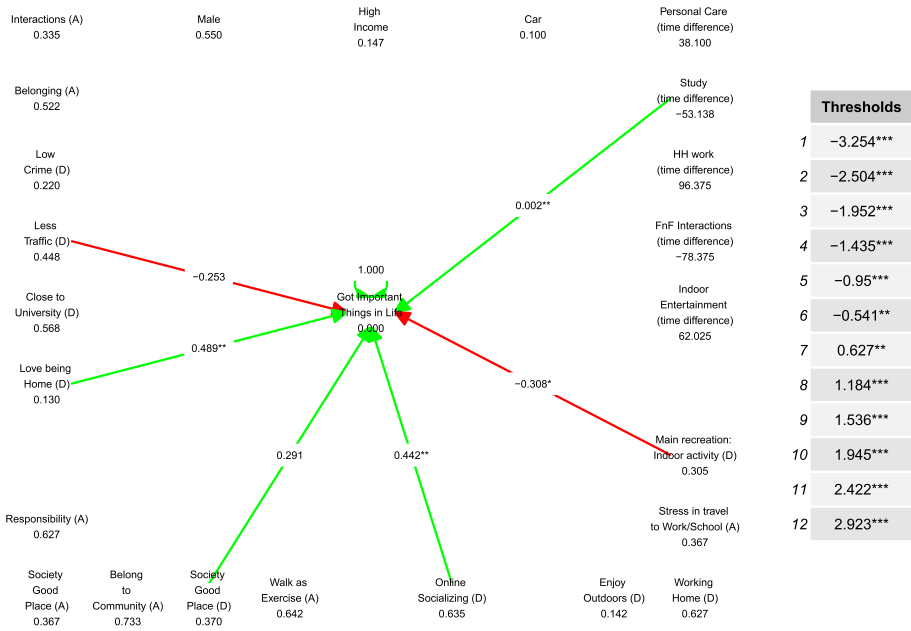


Fig. 6 Multivariate ordinal model of the shifts: item “Got Important Things” (red arrows are negative effects; green arrows are positive effects; in attitudinal factors (A) means agree and (D) means disagree; the numbers under the independent variables are the corresponding sample means)

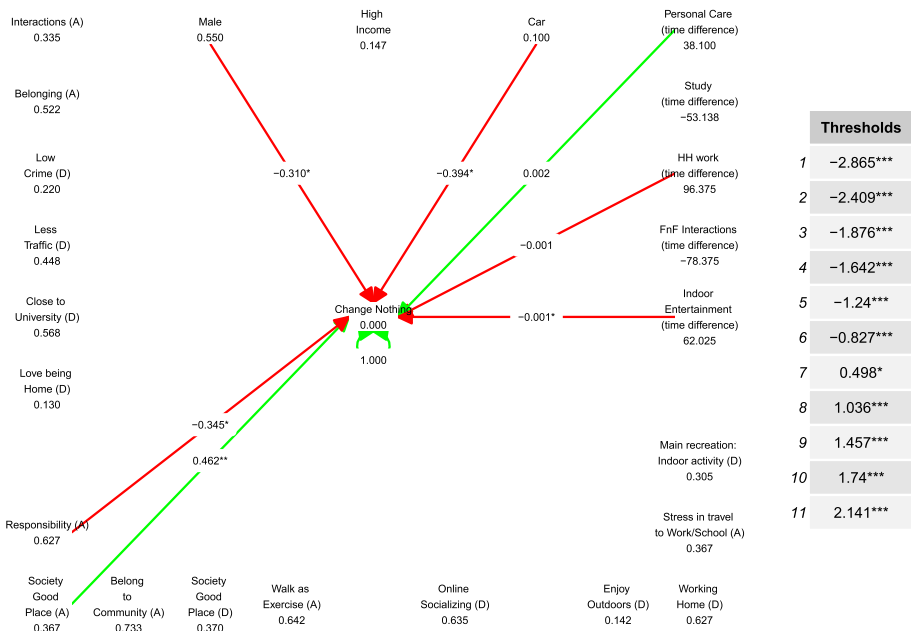


Fig. 7 Multivariate ordinal model of the shifts: item “Change Nothing” (red arrows are negative effects; green arrows are positive effects; in attitudinal factors (A) means agree and (D) means disagree; the numbers under the independent variables are the corresponding sample means)

results of estimating the models are shown in Figs. 3, 4, 5, 6 and 7). The signs of the coefficients in the figures indicate the shifts towards more positive or more negative responses in the SWL Scale item during lockdown compared to the pre-pandemic situation.

Inspection of the results suggests that men had a tendency towards less positive responses during lockdown compared to the period before the pandemic. This is true for four items of the SWL Scale (Figs. 3, 4, 5, and 7). These results suggest that women students may have managed the changes brought by COVID-19 comparatively better than men, which is in contrast to the findings of Akhtarul et al. (2020), who found that university students showed statistically similar anxiety and depressive symptoms during COVID-19 regardless of gender.

Individuals from high income households tended to display positive shifts for two items: “Life close to ideal” and “Satisfied with life”. As seen in Figs. 3 and 5, respondents in high income households (monthly family income BDT 100,000 or higher; 1 USD ~ BDT 85) were more likely to perceive positive attitudes towards “Life close to ideal” and “Satisfied with life” during the lockdown compared to the pre-pandemic situation. The underlying reasons for this could be lower financial stress faced by their households during the public health crisis compared to the other income groups.

With respect to mode of transportation, students who usually traveled by car were more likely to report negative shifts on two items in the SWL Scale. The results indicate that these respondents were less likely to have improved in their assessment of “Satisfied with life” (Fig. 5) and “Change nothing” (Fig. 7). Ownership and use of a car was a factor that generated positive feelings (e.g., freedom, competence, belonging, confidence) and thus, could contribute positively to well-being (Bergstad et al. 2011; Ettema et al. 2012; Vos et al. 2013). However, in the context of low mobility or immobility, it can have the opposite effect on well-being (e.g., Hawryluck et al. 2004; Wilkinson and Badwan 2020). A potential mechanism for this is self-censoring and/or lack of familiarity with other modes; Mercado and Páez (2009), for example, found that older adults who travel by car tend to travel less than users of other modes.

It is interesting to notice that none of the time use variables at the baseline (before COVID-19) were significant in the models. We do not find evidence that these patterns had an effect on changes in well-being (i.e., items of SWL) during the lockdown. That said, several time use change variables were significant in one or more of the models, namely, change in time spent studying, in household work and family care, personal care (e.g. hobbies, physical exercise, yoga, etc.), indoor entertainment, and face to face interactions. To restate these findings, it does not seem to matter how much one slept, worked, studied, etc., before the pandemic, it was the changes in time use patterns what correlates with shifts in the responses to the SWL Scale.

Change in time spent studying is consistently positive; every extra minute spent studying (with respect to the pre-pandemic conditions) increased the odds of having a positive shift in “Life close to ideal” (Fig. 3), “Conditions excellent” (Fig. 4), “Satisfied with life” (Fig. 5), and “Got important things” (Fig. 6). Despite an average decrease in time spent studying in the sample (see Table 3), it is possible that studying became a meaningful activity with a positive impact on satisfaction with life for those who managed to maintain or increase their study time. Also, those who had the opportunity to spend more time on personal care (e.g., hobbies, physical exercise, yoga) were more likely to experience positive outcomes in “Change nothing” (Fig. 7) compared to the pre-pandemic situation. The last time use variable that had a positive impact on any SWL Scale items was face to face interaction (“Conditions excellent” and “Satisfied with life”); although on average less time was spent on this activity during the pandemic, we find a positive correlation between

additional time spent in face to face contact (with respect to the baseline). The results support the findings from M. Lee et al. (2019) suggesting that face to face interactions positively influence the well-being of university students but online interactions detract from it (Fig. 8).

In contrast to the preceding activities, some of which became more restricted, the lockdown seems to have led to a surplus of time for indoor entertainment, such as listening to music, reading books, watching TV, movies, online games, etc., in lieu of time outside or in other leisure activities (see Table 3). Alas, every additional minute spent in such activities reduced the odds of a positive shift in “Life close to ideal” (Fig. 3) and “Change nothing” (Fig. 7). Unlike other meaningful activities, solitary consumption of entertainment seems to have had a detrimental effect on satisfaction with life. In this respect, previous studies have shown that both mobility and immobility have impact on university students’ well-being (e.g., Wilkinson and Badwan 2020; Finn 2017) and time spent on internet negatively impacted the SWB of university students (Afroz 2016; Koç 2017). Another important observation relates to spending time in household work and family care, which shows a negative correlation with “Change nothing”. This suggests that more time spent on household works and family care tends to accompany downward shifts in item “Change nothing”. Covid-19 placed a tremendous burden of household works on families with a disproportionate balance between women and men’s household work distribution, which has been found to affect well-being as well. Satisfaction with job or family life was found to decrease with the extra loads of both household and professional work (Boca et al. 2020; Möhring et al. 2021).

Research shows that noise from traffic creates annoyance and disturbs daytime relaxation, besides worsening sleep, which can have negative impacts on well-being (e.g., Ohrstrom et al. 2006; Gidlöf-Gunnarsson and Öhrström 2007). In our case, respondents

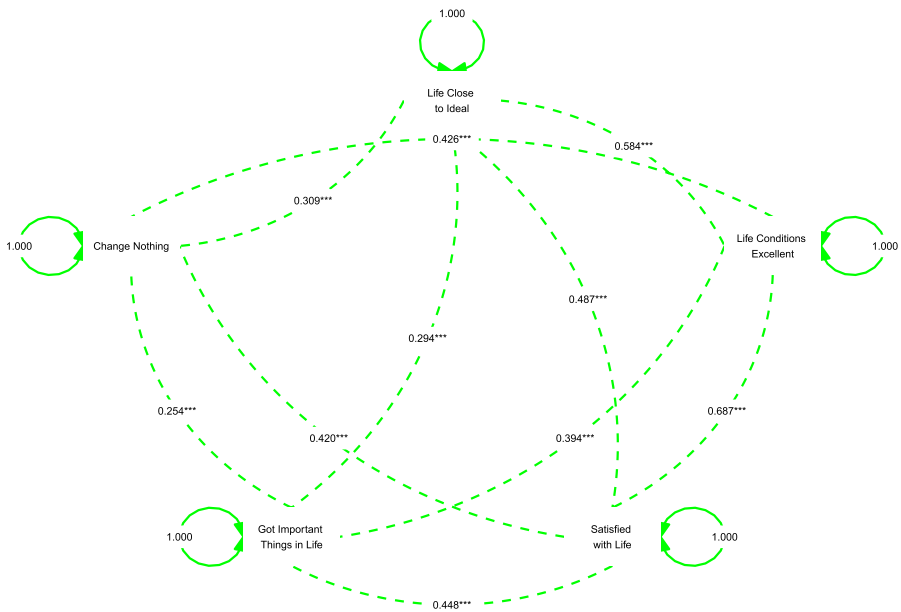


Fig. 8 Covariances among the items of the SWL (note that for identification purposes the variances of the outcomes are standardized to one)

who felt that there was traffic congestion in their neighborhood displayed lower odds of having improved their outlook in three SWL Scale items: “Life close to ideal” (Fig. 3), “Conditions excellent” (Fig. 4) and “Got important things” (Fig. 6). Respondents who disagreed that there was a low rate of crime in their neighborhood tended to have positive shifts in two items: “Conditions excellent” (Fig. 4) and “Satisfied with life” (Fig. 5). It is not clear whether rate of crime went down during the pandemic, but that would be a possible explanation for these results. In terms of proximity to school, those who felt that they live far from school had lower odds of a positive shift in “Satisfied with life” (Fig. 5). Respondents who disagreed that they love being at home with their families had a tendency towards positive shifts on “Got important things” (Fig. 6) during the pandemic. This can be related to findings reported by Ratelle et al. (2013), which indicate that when university students perceive support from their family, friends, and romantic partners, they tend to have higher levels of SWB. An important difference during the pandemic that bears noting is the need to maintain social distancing, which caused disruptions to social life and may have led to feelings of disconnection from significant ones and communities.

Social life and sense of belonging are also factors reported in previous SWB studies. In this respect, there are reports that people with strong social bonds, feelings of being socially included, and free from the stress and hustle experienced during traffic congestion were more likely to have positive SWB (Archer et al. 2013; Delbosc and Currie 2011; Vos et al. 2013). Focusing on university students, self-esteem and social support were found to influence satisfaction with life among students (Kong et al. 2013). Our results suggest that having a positive outlook on society had a positive effect on “Life close to ideal” (Fig. 3), “Satisfied with life” (Fig. 5), and “Change nothing” (Fig. 7). Contrariwise, those who disagreed that society is a good place to live were more likely to have a positive effect on “Got important things” (Fig. 6). It is interesting to see, as well, the negative shift on “Conditions excellent” (Fig. 4) by those with feelings of belonging to a community. In contrast, a positive effect is seen on “Conditions excellent” (Fig. 4) for those who agreed that they have a sense of belonging.

Sense of control is another factor that can positively affect well-being (Lachman and Weaver 1998). In the context of the pandemic, it appears that respondents who generally were good at managing responsibilities had their locus of control dislocated amid external and catastrophic circumstances. At the very least, changes in travel and activity engagement can prove a challenge to scheduling and managing daily activities. In this way, respondents who agreed that they are good at managing responsibility were more likely to report negative shift on three items: “Life close to ideal” (Fig. 3), “Conditions excellent” (Fig. 4), and “Change nothing” (Fig. 7).

The final set of attitudinal variables relate to lifestyles. As seen in the Fig. 4, respondents who agreed that their commute was stressful displayed positive shifts on “Conditions excellent” during the lockdowns, when commuting was limited. In a similar vein, respondents for whom daily walking was part of their physical activity, the lockdown appears to have somewhat worsened their outlook, as they were less likely to see an improvement on item “Life close to ideal” (Fig. 3). There is now an extensive body of literature on the positive experience of commuting (e.g., Redmond and Mokhtarian 2001; Humagain and Singleton 2020) including for active travelers (e.g., A. Paez and Whalen 2010; Whalen et al. 2013; Krizek 2018), and our results suggest that for students who do not find their commute stressful or who consider walking part of their quotidian physical activity experiencing negative impact on well-being items. Perhaps, those positive aspects went missing from their daily routine during the lockdowns.

With respect to use of online tools, respondents who did not prefer online socializing tended to report improved responses on two items “Life close to ideal” (Fig. 3) and “Got important things” (Fig. 6). The positive shifts for those who did not prefer online socializing are more difficult to explain, since so many interactions took place online during the pandemic. Along a related line, respondents who disagreed that they prefer to work/study from home rather than going to school or to a workplace were more likely to have negative shifts on two items: they are less likely to have a positive shift in “Conditions excellent” (Fig. 4) and “Satisfied with life” (Fig. 5). These findings add to ongoing debates on whether performing an activity sans travel (e.g., tele-work, online communication) is beneficial to SWB (Mokhtarian 2019) and to productivity (Shi et al. 2020). On the other hand, students who disagreed that they enjoy being outdoors were more likely to experience a positive shift in “Life close to ideal” and “Conditions excellent”. Finally, those who disagreed that their main source of recreation is indoor activities (e.g. computer gaming, reading books, listening music) tended to see negative shifts on item “Got important things”.

Conclusion

In this research we considered the implications of immobility on subjective well-being among students in Dhaka, Bangladesh. We investigated how socio-economic and demographic attributes, time use patterns, and a battery of attitudinal variables correlate with the satisfaction with life of students in institutions of higher education in Dhaka, Bangladesh.

This research adopted the lens of immobility and contributes new evidence to the literature about subjective well-being among a population segment not usually affected by this condition. As the pandemic kept away students from school, the mental health and well-being implications of this vulnerable population have become of interest. Further, our study is based on a city in the global south context, evidence of which remains scarce in the transportation literature. Analysis was based on *changes* in well-being from before to during COVID-19; to this end, we estimated multivariate regression model of the shift (in steps) in the responses to the SWL Scale. We developed a combined model of each of item of Satisfaction of Life scale, and thus add to ongoing debates regarding measurement scale of well-being by showing the differential effect of various factors on individual items/components of a specific measurement scale.

The analysis supports earlier studies that have found that males and those who are not members of higher income households are more likely to experience a negative impact on their well-being during COVID-19. People whose usual mode of transport is the car are also more likely to experience negative satisfaction with life outcomes - although it is unclear whether this is because of self-censoring, being located in places with limited transportation alternatives (e.g., Lavery et al. 2013), or a combination of these factors.

Our results also provide information about changes in time use patterns with respect to the baseline. It is clear that immobility during the COVID-19 means limited outdoor activity engagement and face-to-face interactions. That said, we find that individuals who could spend extra time on studying, personal care such as hobbies, physical exercise, yoga, etc. and in face-to-face interactions during COVID-19 were more likely to experience a positive change in satisfaction with life. On the other hand, time spent on online activities and indoor entertainment tended to worsen satisfaction with life. In particular, spending more time indoors with a sedentary lifestyle is associated with worse satisfaction with life outcomes.

The results regarding attitudinal attributes produced rich results that paint a complicated picture for transport policy and practice. As COVID-19 related stay-at-home mandates and fear of transmission made many of the respondents stay at home, those who love to be outdoors are more likely to see a negative impact on their well-being. Disruptions in social life, and feelings of isolation and detachment also seem to impact them negatively.

Relevant policy implications to improve well-being would be to encourage more active lifestyles. Burdett et al. (2021) found that decreases in outdoor recreational activities during lockdown adversely impacted well-being. Due to the lockdown, there were disruptions to lifestyles, sleep, and activity time use. These disruptions have been found to affect mental health (Giuntella et al. 2021). Our study suggests that immobility and increased time in indoor entertainment deteriorated satisfaction with life among students in Dhaka during the pandemic. On the other hand, an incidental benefit of the pandemic could be the formation of habits; as suggested by Brand et al. (2020), lockdowns offered a unique opportunity to promote physical activity due precisely to changing demands for time (e.g., no need to commute). Also, lifestyle and habits impact well-being (Giuntella et al. 2021). Our study suggests that spending time on personal care such as hobbies, physical exercise and face to face interactions can improve satisfaction with life among students. As noted by Giuntella et al. (2021), physical activity is associated with other lifestyle behaviors such as social interactions as it is often undertaken in a social context. Encouraging students to walk or cycle for recreation can offset some of the negative impacts of immobility and perhaps help to maintain social connections. Recreational active travel during the lockdown, in addition to helping individuals to regain some mobility during lockdown, also has limited transmission risks when conducted outdoors (Dunton et al. 2020; Hawryluck et al. 2004; Wilkinson and Badwan 2020; Finn 2017) and can create positive emotional outcomes (Vos et al. 2016; De Vos 2020). Existing evidence suggests that exercising can help individuals to get through hard times easily (Silverman and Deuster 2014), and we suggest that incorporating walking and cycling for recreation should be part of a menu of interventions to increase physical activity. This adds urgency to ensuring that adequate facilities can be promptly prepared to accommodate this (see Lovelace et al. 2020).

One limitation of this study is that it is based on a cross-sectional survey conducted during the partial lockdown period in Dhaka, thus, causal effects cannot be established. Second, use of an online platform to collect data means that we worked with a convenience sample. Nevertheless, as young adults and students are more familiar with online platforms, we tend to believe that the sample captured the variability of Dhaka's university and college student population to a good extent. Moreover, collecting data through online surveys were the sole practicable way during COVID-19 (e.g., Brand et al. 2020; Astroza et al. 2020; Dong et al. 2020; Dunton et al. 2020). However, random selection of participants, collecting representative samples and face-to-face surveys are highly encouraged for future studies. In terms of time use, the study collected time spent in school and workplaces together, but we acknowledge that there might be differences between students who worked and who did not work in terms of the impacts of time use on well-being.

Literature suggested that financial conditions and working schedule and duration impact well-being, specially during COVID-19 (Keckojevic et al. 2020; Asanov et al. 2021), which this study is unable to capture. Regarding the characteristics of residential location, the survey used self-reported perceptions of the students. GIS-based residential location-level data are unfortunately not available in Dhaka, and collecting location-specific crime and accident data for Dhaka was beyond the scope of this project. That said, there is evidence that individual perceptions of the environment have remarkable geographical consistency (A. Paez 2013).

Regardless of the limitations, this study adds evidence that could inform decision makers on how to increase the well-being of the university students in the context of a densely populated city in the global south by using sustainable transportation and lifestyle choice policies. Encouraging students in recreational use of active modes can improve their well-being during the pandemic, and investing on active transportation, providing infrastructure, and active travel friendly urban design can become longer term policy goals.

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Author Contributions SJ: Conceptualization, Formal analysis, Investigation, Data Curation, Writing - Original Draft, Visualization. AP: Conceptualization, Methodology, Writing - Original Draft, Visualization, Supervision

Declarations

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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