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How Does Time Use Differ between Individuals Who Do More versus Less Foodwork? A Compositional Data Analysis of Time Use in the United Kingdom Time Use Survey 2014–2015

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Abstract: Background: Increased time spent on home food preparation is associated with higher diet quality, but a lack of time is often reported as a barrier to this practice. We compared time use in individuals who do more versus less foodwork (tasks required to feed ourselves and our households, including home food preparation). Methods: Cross-sectional analysis of the UK Time Use Survey 2014–15, participants aged 16+ (N = 6143). Time use over 24 h was attributed to seven compositional parts: personal care; sleep; eating; physical activity; leisure screen time; work (paid and unpaid); and socialising and hobbies. Participants were categorised as doing no, 'some' (<70 min), or 'more' foodwork (≥70 min). We used compositional data analysis to test whether time-use composition varied between these participant groups, determine which of the parts varied between groups, and test for differences across population subgroups. Results: Participants who spent more time on foodwork spent less time on sleep, eating, and personal care and more time on work. Women who did more foodwork spent less time on personal care, socialising, and hobbies, which was not the case for men. Conclusion: Those who seek to encourage home food preparation should be aware of the associations between foodwork and other activities and design their interventions to guard against unintended consequences.

Keywords: foodwork; home food preparation; compositional data analysis; time-use data

1. Introduction

Observational evidence suggests that higher frequency of making [1–5] and eating [4,6,7] home-prepared meals, while not a prerequisite for a healthy diet [8], is associated with improved dietary intake and health outcomes. Substantial energy has been devoted to understanding the modifiable determinants of home food preparation and increasing food preparation in households [9–13].

Existing research has explored how time spent on 'foodwork', the tasks required to feed ourselves and our households, including preparation, shopping, cleaning up, and washing dishes [14], has evolved in different countries [15–17]. A study of time use in the UK found that time spent on food preparation decreased by 16 min between 1975 and 2000, while participation in home food preparation had increased (from 75% to 83% of the sample), a change driven principally by the increasing participation of men in this task [18].

Increased time spent on foodwork has been shown to positively impact diet [19]. More time spent on foodwork may represent a higher frequency of preparing meals at home or a particular kind of home food preparation, preparing food 'from scratch' [20] or from unprocessed or minimally processed ingredients, which has been posited to be particularly important to achieving high diet quality [21].

Beyond its potential association with diet quality, time is an important dimension in understanding home food preparation due to the frequency with which a lack of time is cited as a barrier and the importance of time and convenience in structuring food practices and attitudes towards them [22]. In numerous studies, participants report preparing food at home less often than they would like because they feel they lack the time [20,23–28].

As interventions designed to increase the frequency of home food preparation and increase cooking 'from scratch' are being implemented [10,11,13], this key barrier is worthy of further exploration. While income-related barriers to healthy eating have been explored and, to some extent, integrated into theory and intervention design, evidence assessing associations between time scarcity and healthy eating behaviours is more limited, and few interventions have explicitly addressed a lack of time as a barrier to healthy eating [29]. Where home food preparation interventions have sought to address time scarcity, they have sometimes done so by providing quick recipe ideas on cards or websites, such as the online cooking and nutrition resource 'No Money No Time' [30].

While everyone has the same number of hours in a day, time 'poverty' or 'scarcity' refers to more demands being placed on those hours [20,31]. These demands can come in the form of paid employment, domestic tasks, or caring duties [20]. Indeed, individuals with high demands on their time, such as parents of young children who are employed outside the home, have been shown to prepare food at home less frequently [23,27]. However, Southerton and Tomlinson highlight that the experience of 'harriedness', endemic in contemporary life, may go beyond this requirement to spend time on necessary tasks and extends to other aspects of time, such as the weakening of socio-temporal structures, where increasingly unfixed schedules for things like work and meal times make it difficult to coordinate activities with families and households, and 'temporal density', involving multitasking and the erosion of boundaries between discrete tasks [32]. Nevertheless, the impact of demands on time in the form of paid or unpaid work to the experience of harriedness remains important. In an analysis of various measures of 'time intensity', including multitasking and task switching and their association with self-reported feelings of being rushed, it was found that the strongest predictor of feeling rushed was time spent on work [33].

Understanding what a lack of time means, practically, may be helpful in understanding whether different home food preparation interventions might be expected to work. It is also worth exploring whether making the desired change to more time spent on foodwork might be expected to lead to unintended consequences, depending on how individuals accommodate this new demand on their time and where they draw time from. To explore this, foodwork must be examined in conjunction with other daily activities.

Compositional data analysis is a technique that has recently been applied to the study of health behaviours, such as physical activity [34,35]. This approach construes a 24-h time budget as a composition made up of different activities, or parts, and takes into account some key properties of time: that time is bounded, and that budgeting time involves trade-offs between different activities.

While compositional data analysis has been applied in the field of nutrition to explore the nutritional composition of diets [36], it has not yet been applied to time spent on food practices in the context of other daily activities. The aim of this study was to use time-use diaries to explore the cross-sectional relationship between the extent of engagement with foodwork and the structure of a 24-h time budget (i.e., how much time people spend on daily activities). In analysing this time budget, we examined some activities which are health-promoting, such as sleep and physical activity, and others which are necessary to social, personal, and economic wellbeing, such as work, socialising, and leisure.

We further identified differences in this relationship between population subgroups, looking at three dimensions which have been shown to impact both time use and foodwork: gender, economic activity, and the presence of children in the household [15,23,27,37,38].

2. Materials and Methods

2.1. Data Source

This study presents a secondary analysis of the 2014–15 United Kingdom Time Use Survey (UKTUS) [39], a cross-sectional national survey of UK residents aged 8 years and over. Private addresses were randomly sampled from UK postcode sectors [40]. From a total sample of 11,860 addresses, 10,479 were eligible. Ineligible addresses included non-residential addresses, holiday homes, and vacant buildings. Within each eligible household, one individual was asked to complete a household demographic questionnaire. All individuals in included households were asked to complete an individual demographic questionnaire and two 24-h time-use diaries (one weekday and one weekend day). Of the 10,479 eligible households, 40.4% responded, meaning a household questionnaire was completed, along with an individual questionnaire and one or two diary days from at least one resident. The study was approved by the Research Ethics Committee of the Department of Sociology at the University of Oxford (2014_01_02_R1).

2.2. Time Use Diaries

Participants were asked to fill out a time-use diary for one weekday and one weekend day selected by the study team. Diaries started at 4 am and covered a full 24-h period. This period was divided into 10-min time intervals, and participants were asked to fill in a primary activity for each time interval. All responses were given in free text and coded by the study team using a priori activity codes [40].

2.3. Exclusion Criteria

As suggested by the UKTUS study team, diaries characterised by three 'flags' indicating poor quality were excluded. These flags were: having more than 90 min of missing time, reporting fewer than seven episodes of activity (i.e., seven changes between activity or location), and missing two or more of four basic activities (sleeping/resting, eating/drinking, personal care, and exercise/travel) [41]. We further excluded any diaries that did not report a full 24 h of eligible activity codes, or that reported zero minutes spent on sleep. Of the diary days that passed these quality checks, we randomly selected one day for each participant aged 16 years and over.

2.4. Definition of Exposure (Foodwork)

We summed daily time spent on foodwork (time spent on shopping for food, food preparation and management, or washing dishes) for each participant. We assigned participants to one of three foodwork categories based on the amount of foodwork they had reported: 'no foodwork' (no time spent); 'some foodwork' (below the median amount of time spent for those who engaged in foodwork); and 'more foodwork' (above the median amount of time spent for those who engaged in foodwork).

2.5. Definition of Outcome (Time-Use Composition)

Foley et al. provide an overview of the compositional data analysis paradigm in health research [34]. Briefly, compositional data are made up of mutually exclusive parts which sum to a whole, such as, in this case, 24 h [42]. Transforming time-use data into a composition requires classifying time spent into different categories, with each category representing a part of the composition. We partitioned each participant's time-use diary into seven mutually exclusive activity sets (parts) based on the activity they had reported in each time interval.

1. Personal care (e.g., showering, grooming).
2. Sleep (including time spent in bed sleeping or in bed while not doing another activity).
3. Eating.
4. Physical activity (including walking and active transport by foot or bicycle).
5. Leisure screen time.
6. Work (including paid work as well as unpaid domestic work, such as foodwork, housework, and care work).
7. Socialising and hobbies not captured elsewhere.

The specific activities included in each part are described in Appendix A.

All participant time could be allocated to one of these parts. Time spent travelling was allocated to the activity it enabled, with the exception of active travel (by foot or bicycle), which was coded to physical activity. Our parts reflected an interest in activities that are important to physical health, such as sleep and physical activity, as well as activities that may be important for social, economic, or psychological wellbeing, such as work or socialising.

Compositional information is relative rather than absolute, with ratios between parts being the primary interest. Compositional data analysis has the advantage of taking into account the co-dependent nature of compositional data, such as minutes available in a day, but standard analysis techniques, such as regression, cannot be directly applied to compositional data [34]. In order to apply these techniques, a common approach is to transform and express compositions as log-ratio coordinates (generated, in this analysis, using an isometric log-ratio transformation [43]). Expressed in this form, compositions may be treated as either exposures or outcomes in statistical models. Coordinates may then be back-transformed into original units for interpretation.

Because log-ratio coordinates may not be applied to zero values, the presence of zero values in one or more parts of a composition prohibits the use of compositional data analysis. Zeros in compositional data may be theorised as either 'rounded', representing a small nonzero value that falls below some detection limit, or 'essential', meaning a true zero and representing the complete absence of that part in the composition. Rounded zeros have been dealt with by imputing small nonzero values to replace them, but essential zeros remain a core challenge for compositional data analysis [44].

For this analysis we treated zeros as rounded, replacing zeros with small values under 10 min by drawing time from other parts to create imputed compositions. To do so, we used the log-ratio data augmentation algorithm function included in the R package zCompositions, which is a Markov Chain Monte Carlo algorithm and allows for the estimation of values below the detection threshold, while maintaining the relative structure of the data [45].

Our parts were defined in such a way that it seemed likely that most participants would spend at least a small amount of time engaging in each of the groups of activities, meaning reported zeros represented true small numbers. For example, a participant who had recorded no time spent socialising may still have greeted family members or colleagues or conversed with a supermarket cashier.

2.6. Covariates

Covariates were self-reported age, gender, economic activity (as defined by the Office for National Statistics: economically active, i.e., in paid employment or actively seeking work, or economically inactive [46]), occupational class (based on current or most recent employment using the three-class version of National Statistics Socio-Economic Classification [47], or not applicable for those who had never been in paid employment), age at leaving full-time education, and presence of children under the age of 16 in the home, as well as diary day type (weekend day or weekday) for the selected diary.

2.7. Analysis

We described the socio-demographic characteristics and the median time spent on foodwork for the whole sample and in each foodwork category. We conducted chi-square tests or one-way ANOVAs

to identify statistically significant differences in the socio-demographic characteristics of each foodwork category. We then described the pattern of zero values in the time-use composition. All subsequent analyses were performed on the imputed compositions.

Because compositional data are constrained to sum to a whole, the values such data can take are bounded. As a result, they operate in a subset of real sample space known as the simplex [42]. As noted above, many analysis techniques traditionally employed in health research (in particular, linear regression) cannot be directly applied to compositional data, because such techniques assume that data are operating in real sample space [34]. In order to apply such techniques to compositional data, the data are transformed so that they operate in real space for which several approaches have been developed. For this analysis, we applied an isometric log-ratio (ilr) transformation to the data [43,48]. This transformation uses orthonormal bases to produce a set of ilr coordinates numbering one fewer than the number of parts. Each coordinate takes the form of a ratio between one part and another part or the geometric mean of several parts, in this case, sleep: personal care; eating: geometric mean of sleep and personal care; physical activity: geometric mean of sleep, personal care and eating; and so on [49].

In order to test for differences between time-use compositions for participants reporting no foodwork, some foodwork, and more foodwork, we followed the procedure suggested by Martìn-Fernandez and colleagues to interpret differences between groups of compositional data [49].

First, we used a multivariate analysis of variance (MANOVA) applied to the ilr transformation of the composition to determine whether the three groups differed [49]. We checked the assumptions of the MANOVA as recommended, using a multivariate goodness of fit test (from the R package compositions [48] developed based on Aitchison's recommendation [42]) to verify the normality of residuals and a visual inspection of a dendrogram to verify the homogeneity of variances and covariances [48,49]. These tests suggested the assumptions of the MANOVA were met.

Second, if the results of the MANOVA suggested rejecting the null hypothesis of equality of means between the three groups of compositions, we used a Hotelling's T-squared test, the multivariate generalisation of a standard t-test, to determine which pair of groups—none and some, or some and more—were different [49]. We chose not to analyse the third potential pair, none and more, as being less conceptually meaningful than the other pairs and, therefore, yielding results that would be difficult to interpret.

Third, where differences between two groups were detected, it was necessary to determine which of the individual parts differed. We estimated adjusted compositional means (i.e., adjusted for all covariates: age, gender, economic activity, occupational class, age at leaving education, presence of children in the household, and diary day type) for each group [34]. To do so, we created linear regression models with the ilr coordinates as outcome variables and the categorical foodwork variable as the exposure, along with the other covariates. Using the R package lsmeans [50], we estimated the adjusted mean ilr coordinate value for each of the six ilr coordinates. We did this separately for each foodwork category (none, some, and more), generating a complete set of six ilr coordinates for each category. Finally, we back-transformed these ilr sets, using the same ilr partitioning system, to obtain the adjusted compositional means for each foodwork category (none, some, and more).

Finally, we calculated the log-ratio differences in adjusted compositional mean between both pairs of groups: none vs some and some vs more. Log-ratio differences are log-transformed ratios, where the numerator is the model-adjusted minutes per day spent on a given part in a given group of participants, and the denominator is the model-adjusted minutes per day spent on the same part in another group of participants. For example, this could be the model-adjusted time spent sleeping in participants who do some foodwork compared to the model-adjusted time spent sleeping in participants who do no foodwork. In order to determine whether the difference in time spent was significant at the critical level, we constructed confidence intervals for each part using a bootstrap technique [49]. Confidence intervals that crossed zero indicated that there was no between-group difference for this part.

We entered interaction terms into the Hoteling's *T*-squared models to determine whether the relationship between foodwork and time-use composition differed by gender, employment status, or presence of children in the home. Where the interaction term was significant, we stratified the sample and performed the analysis again for each subgroup, creating estimates for, for example, men and women separately.

For this analysis we used the open source software R (Version 3.6.1, R Foundation for Statistical Computing, Vienna, Austria,) and a number of bespoke packages for the analysis of compositional data, including Hotelling, lsmeans, Compositions, zCompositions, and robCompositions. Throughout this analysis we adjusted the critical level (0.05) in proportion to the number of groups analysed using the Bonferroni correction in order to prevent the artificial increase of the Type I error rate, as suggested by Martìn-Fernandez and colleagues [49]. This resulted in a critical level of 0.017, which was applied throughout.

3. Results

3.1. Sample Characteristics

The full data set consisted of 16,533 time-use diaries from 8274 participants. Of these, 23 diaries failed general quality checks, and 5005 diaries failed checks specific to this analysis (4988 reporting less than 24 h and 17 reporting no sleep). Of these valid diaries, 1182 were filled out by those aged under 16 years. After applying these exclusion criteria, we randomly selected one diary day from each participant, creating an analytic sample of 6143 diaries from 6143 participants.

Table 1 describes the characteristics of the analytic sample by foodwork category. Among participants who reported doing foodwork, the median amount of time spent on foodwork was 70 min. Participants doing less than 70 min of foodwork per day were, therefore, assigned to the 'some' foodwork category, with participants doing 70 min or more assigned to the 'more' foodwork category.

Participants in the higher foodwork categories were significantly older and more likely to be women than participants in the lower foodwork categories. Economically inactive participants—a group dominated in this sample by retired individuals—were over-represented in the more foodwork category. Meanwhile, participants who were still in full-time education were over-represented in the no foodwork category. Weekdays were slightly over-represented in the some foodwork category, perhaps reflecting shorter but more regular foodwork on days when participants were at work or school, while more foodwork is slightly more common on weekend days.

3.2. Differences between Time-Use Compositions Across Foodwork Categories

All analyses were performed on the imputed compositions, where zero values were replaced with small nonzero values. Patterns of zeros in the time-use composition are reported in Appendix B. After adjusting for covariates, there was a statistically significant difference in time-use composition between those reporting no foodwork, some foodwork, and more foodwork. The Hotelling's *T*-squared test further suggested there was a statistically significant difference in time-use composition between both pairs of groups: no foodwork and some foodwork, and some foodwork and more foodwork.

The model-adjusted compositional means for each part, presented separately for those reporting no foodwork, some foodwork, and more foodwork are shown in Figure 1. Symbols indicate a statistically significant log-ratio difference between foodwork categories for each part ($p < 0.017$).

The numerical values underlying Figures 1–3 are in Appendix C.

With higher amounts of foodwork, more time was spent on work (a part which includes foodwork but also all other forms of work, both paid and unpaid), with participants who did more foodwork spending 102 min more on work than those who did some foodwork, and 137 min more on work than those who did no foodwork. Meanwhile, less time was spent on sleep.

Table 1. Characteristics of analysis sample (n = 6143).

	No Foodwork	**Some Foodwork**	**More Foodwork**	**Total**		
Participants (n)	1455	2454	2234	6143		
Foodwork (mins/day):						
Median (IQR)	0 (0)	30 (20,50)	110 (90,150)	40 (10,90)		
Geometric mean	0	28.5	116.2	0	F	*p* value
Age (years, mean (SD))	41.8 (18.7)	46.8 (17.6)	53.2 (17.3)	47.9 (18.3)	191.4	<0.001
		n (%)			Pearson χ^2	*p* value
Gender						
Men	958 (65.8)	1268 (51.7)	679 (30.4)	2905 (47.3)	475.65	<0.001
Women	497 (34.2)	1186 (48.3)	1555 (69.6)	3238 (52.7)		
Economic activity						
Economically active	982 (67.5)	1617 (66.2)	1103 (49.6)	3702 (60.5)	173.05	<0.001
Economically inactive	472 (32.5)	827 (33.8)	1120 (50.4)	2419 (39.5)		
Occupational grade						
Professional or managerial	444 (30.6)	920 (37.5)	736 (33.0)	2100 (34.2)	47.15	<0.001
Intermediate	381 (26.3)	695 (28.3)	629 (28.2)	1705 (27.8)		
Routine and semi-routine	407 (28.1)	611 (24.9)	616 (27.6)	1634 (26.6)		
Not applicable	217 (15.0)	226 (9.2)	251 (11.3)	694 (11.3)		
Children under 16 in household						
Yes	524 (36.0)	794 (32.4)	717 (32.1)	2035 (33.1)	7.21	0.027
No	931 (63.4)	1660 (67.6)	1517 (67.9)	4108 (66.9)		
Age at finishing full-time education						
Still in education	333 (22.9)	421 (17.2)	228 (10.2)	982 (16.0)	122.31	<0.001
16 or under	547 (37.6)	891 (36.3)	982 (44.0)	2420 (39.4)		
Over 16	575 (39.5)	1142 (46.5)	1024 (45.8)	2741 (44.6)		
Diary day						
Weekday	720 (49.5)	1304 (53.1)	1069 (47.9)	3093 (50.4)	13.64	0.001
Weekend	735 (50.5)	1150 (46.9)	1165 (52.2)	3050 (49.7)		

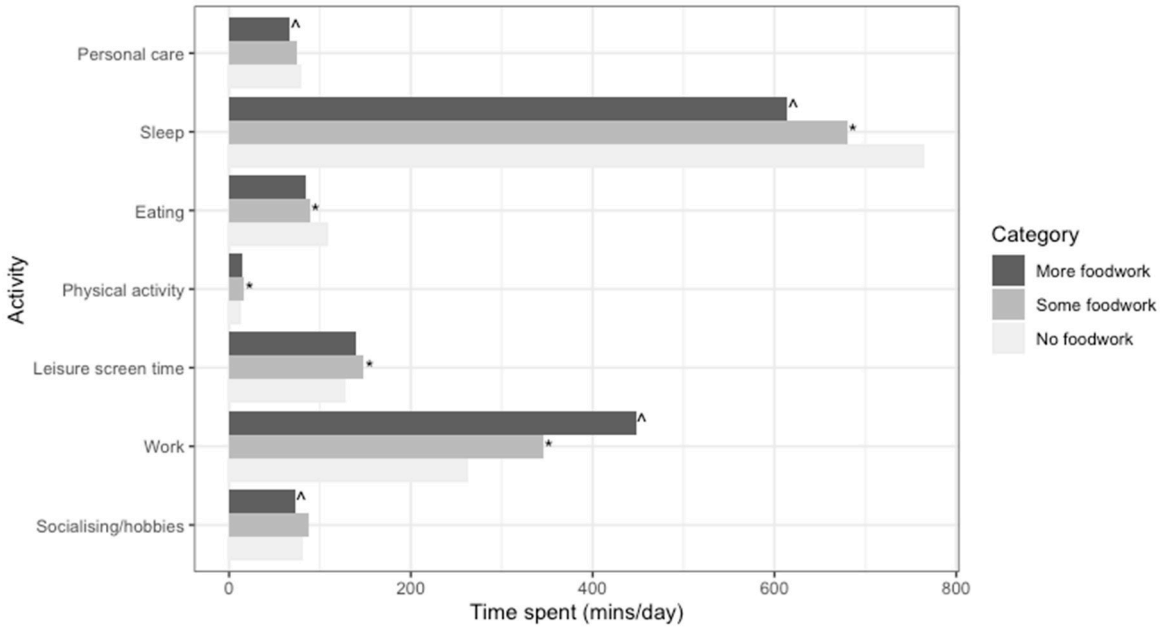

Figure 1. Model-adjusted [a] compositional means by foodwork category (n = 6143) [a] Adjusted for age, gender, employment status, education, occupation, presence of children, and diary day type. ^ Statistically significant log-ratio difference between more and some foodwork for this part. * Statistically significant log-ratio difference between some and no foodwork for this part.

Relative to participants who did some foodwork, participants who did no foodwork spent more time eating (20 min, see Appendix C) and less time on physical activity (3 min) and watching screens (20 min). Meanwhile, participants who did more foodwork spent less time on personal care (12 min) and socialising and hobbies (15 min) relative to participants who did some foodwork.

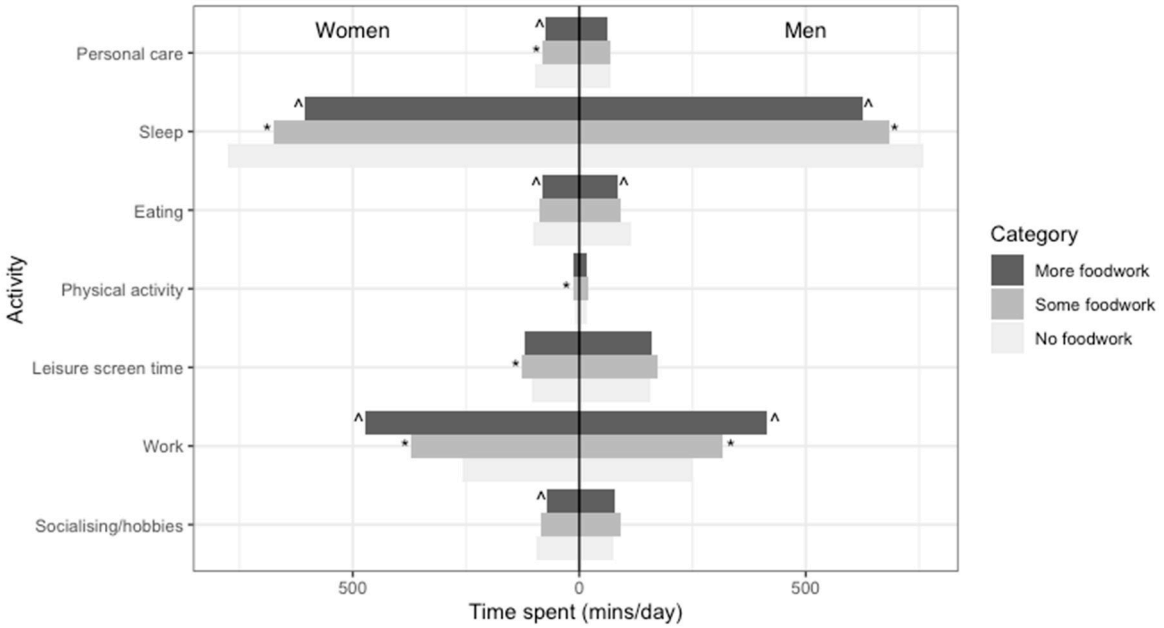

Figure 2. Model-adjusted [a] compositional means for men and women by foodwork category (n = 6143) [a] Adjusted for age, gender, employment status, education, occupation, presence of children, and diary day type. ^ Statistically significant log-ratio difference between more and some foodwork for this part. * Statistically significant log-ratio difference between some and no foodwork for this part.

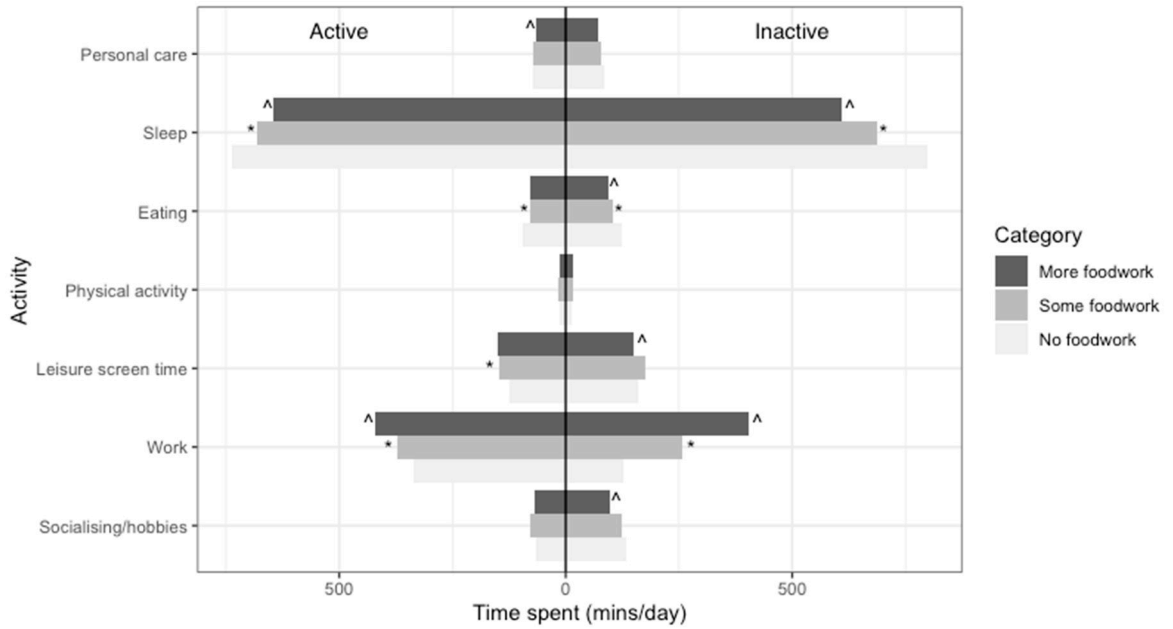

Figure 3. Model-adjusted [a] compositional means for economically active and inactive participants by foodwork category (n = 6143) [a] Adjusted for age, gender, employment status, education, occupation, presence of children, and diary day type. ^ Statistically significant log-ratio difference between more and some foodwork for this part. * Statistically significant log-ratio difference between some and no foodwork for this part.

3.3. Effect Modification

A statistically significant interaction ($p < 0.017$) was found for gender and economic activity in the association between foodwork and time-use composition but not for the presence of children in the household. The results of stratified analyses are presented in Figures 2 and 3.

Figure 2 shows that women who did more foodwork spent less time on personal care and socialising and hobbies, which was not the case for men. Further, while both men and women who did more foodwork spent more time on work overall, women in all foodwork categories spent more time on work. This difference was smaller, at 6 min, between men and women who did no foodwork but larger, at 61 min, between men and women who did more foodwork (see Appendix C).

Figure 3 shows that both economically active and inactive participants spent more time on work in the higher foodwork categories. Economically active participants spent more time on work overall, as expected. However, the difference between economically active and inactive participants narrowed with increasing time spent on foodwork: in the no foodwork category, economically active participants spent 207 min more on work than economically inactive participants, while in the more foodwork category, economically active participants spent only 18 min more.

4. Discussion

4.1. Main Findings

This study explored the cross-sectional relationship between time spent on foodwork and the structure of a daily time budget. More time spent on foodwork was associated with less time sleeping and more time working. The latter may be partly explained by the inclusion of foodwork in work. However, for participants who did some foodwork versus no foodwork, the between-group difference in work is substantially larger (82 min, see Appendix C) than the difference in the geometric mean of time spent on foodwork (28 min, see Table 1). This suggests that participants who did some foodwork also did more of other types of work. Between participants who did more versus some foodwork, between-group differences in time spent on work were still larger than in time spent on foodwork

(102 vs. 87 min), but the difference was less substantial. Given the lack of adjustment for covariates and the absence of the closing process for time spent on foodwork, these two groups may spend similar amounts of time on other types of work.

We also identified differences in time spent on foodwork and the structure of a daily time budget between population subgroups. The more foodwork category was dominated by women, while the no foodwork category was dominated by men. Economically inactive participants were over-represented in the more foodwork category.

Women who did more foodwork spent less time on personal care and socialising and hobbies, which was not the case for men. Women in all foodwork categories spent more time on work than their male counterparts. As time allocated to foodwork increased, this difference also increased from 6 to 61 min (see Appendix C).

Both economically active and inactive participants spent more time on work in the higher foodwork categories. The difference between economically active and inactive participants narrowed with increasing time spent on foodwork: in the no foodwork category, economically active participants spent 207 min more on work than economically inactive participants, while in the more foodwork category, economically active participants spent only 18 min more on work (see Appendix C).

4.2. Limitations of the Study

Because of our wish to look at the 24-h time budget as a composition, it was impossible to draw out time spent on foodwork and examine the remaining time in isolation, meaning foodwork is included in both exposure and outcome. However, foodwork (median 70 min/day) made up a relatively small proportion of daily time, and differences in time use were seen across several activity sets.

Time-use diaries tell us about substantive uses of time, but a substantial amount of intellectual labour goes into food planning and management [24,26,51,52]. This may occur alongside other tasks or in a fragmented way, potentially making participants less likely to record it in a time-use diary, meaning that time spent on foodwork may be underestimated here. Further, while time spent on foodwork is associated with diet quality [19], other factors could moderate this relationship, such as ingredients, kitchen equipment, cuisine, or skill.

This analysis uses one 24-h time-use diary from each participant. This one-day window may be less representative of participants' usual time use than a longer diary, particularly for activities which participants engage in only infrequently [44]. However, the activities of interest in this analysis are relatively routine, and the conclusions of the analysis rely on measures of central tendency in the sample as a whole, rather than characterization of individual participants' practices.

In existing research, participants who are more likely to experience time scarcity, such as single or working parents report lower frequency of preparing meals at home [20,23,27]. In contrast, in this analysis adults who lived in households with children were not over-represented in the lower foodwork categories, nor was the presence of a child in the house a significant modifier of the association between foodwork and time use. This difference could be attributable to our relatively rough measure of household structure, with participants being characterized based on the presence of children in their households. This may obscure substantial variation in household structure and responsibility for caring for children in the home. For example, participants with children who are single parents may be expected to spend substantially more time doing caring and housework than participants in dual-parent households. Meanwhile, some participants aged 16 and over may live in households with children, but they may be the siblings of these children rather than their parents. While children of different ages have been shown to contribute to housework [53,54], they generally spend less time on it than adults. Further analysis of foodwork and household structure could use a more differentiated measure to accommodate this variation.

Another explanation may be that the presence of children in the household leads to a different type or rhythm of foodwork, perhaps with more time spent on preparing snacks for children, but lower frequency of preparing what participants see as home-prepared meals. This hypothesis

could be further explored through foodwork episodes combined with a more differentiated measure of household structure.

4.3. Implications of the Findings

These findings do not suggest that doing more foodwork is associated with less time spent on any single activity. Instead, the structure of a 24-h time budget varied by foodwork group across several activities, and this association further varied by socio-demographic characteristics.

In this sample, individuals who did more foodwork spent less time sleeping. Given the use of the compositional mean and the inclusion of daytime naps and all time spent in bed in the measure of sleep used, it is difficult to compare sleep time across different foodwork categories to guidelines, with both low and high amounts of sleep being detrimental to health [55]. However, an analysis of sleep in this sample using more conventional statistical methods concluded that the (arithmetic) mean time spent sleeping was in the recommended range, suggesting an epidemic of oversleeping in this sample is unlikely [56]. Given this, these results may suggest a less health-promoting pattern of sleep is associated with increased foodwork. It is plausible that sleeps acts as a 'time reservoir' from which time can be drawn to accommodate other activities, as has been concluded in studies on time use and physical activity [34,57].

Our results are consistent with existing work, which suggests that women do more foodwork and housework [26,58,59], and that, while women are increasingly in paid employment, they continue to do more than their share of work in the home [38]. This is of interest to our analysis in considering how women structure their time differently in order to accommodate the work they do.

Our findings suggest that gender continues to play a significant role in how foodwork is allocated. Past research suggests that even in households where the idea of domestic work as 'women's work' is not explicitly endorsed, household members present alternative narratives to rationalise a gendered division of labour [26]. One such narrative is centred around health and budgeting: women feel that if they left their (male) partners to prepare meals they would not consider nutrition or cost [26]. As household gatekeepers they therefore feel obliged to take on the task themselves. These differences in the substantive use of time may mask further inequality in the intellectual labour implicit in foodwork: Cairns and Johnston discuss how their female participants would sometimes ask their (male) partners to go to the supermarket but would often frame this task themselves, preparing a list, shortening the list to only the items urgently required, and providing extensive instructions on the exact type of product required [60].

Our findings further show that this unequal responsibility for foodwork extends beyond time spent on foodwork itself to other daily activities, with less time being allocated to personal care, hobbies and socialising by women who do more foodwork than by men who do more foodwork. Practitioners who advocate or intervene to increase home food preparation must be careful to critically engage with gendered ideas around foodwork and responsibility for household health and budgeting.

In stratifying by economic activity, we found that time spent on work increased more substantially among economically inactive participants who did more foodwork than among economically active participants. Economically active participants were also under-represented in the more foodwork group, and unsurprisingly spent more time on work overall than those who were economically inactive. This may suggest that there is a limit to how much time participants are willing or able to spend working, whether this work is paid or unpaid.

Previous scholarship has discussed the interaction between time and income, suggesting that these two resources must be allocated in complementary ways: individuals who are more 'time-poor' may buy their way out of certain kinds of unpaid labour, such as working parents who pay for childcare [31,61]. Existing studies suggest this is true of foodwork: increased workforce participation and labour market hours worked by household managers (often women) are associated with increased frequency of consumption of pre-prepared meals, as well as increased expenditure on out of home food, often driving up overall food expenditure [62–64]. While home food preparation is advocated as

an inexpensive strategy for eating healthily [65], in many households time and income poverty coexist, meaning that increasing home food preparation may be difficult. Given the increased financial costs associated with eating a healthier diet [66], these households may struggle to access healthy foods.

4.4. Future Research

While this cross-sectional analysis explores how participants who do more foodwork allocate their time differently than those who do less, it is not clear that these patterns would be replicated in the case of an individual increasing time spent on foodwork as a result of an intervention. Further work is required to determine what the effects on time use of such an intervention might be, and whether there are unintended consequences, such as health detriments due to a loss of time spent sleeping, an uneven allocation of additional work between genders, or a reduced effect for some households due to time and income poverty.

5. Conclusions

We found that time use varied extensively between participants who did more versus less foodwork. Participants who did more foodwork spent less time on sleeping, eating, socialising, and hobbies, while spending more time on paid and unpaid work, particularly when comparing participants who did any foodwork compared to none. This may have repercussions for physical health and broader dimensions of wellbeing.

Gender emerged as an important structuring factor in foodwork and time use. Women were over-represented in the category of participants doing more foodwork. In contrast to men, women who did more foodwork spent less time on personal care and socialising and hobbies.

While further work examining how time use changes as a result of a home food preparation intervention is certainly important, those who seek to encourage more home food preparation should be aware of the associations between time spent on foodwork and time spent on other activities and ensure their interventions guard against potential unintended consequences. Where home food preparation increases as a result of, for example, cooking classes or meal kit provision, re-allocation of time from other activities could be examined to determine what activities may be relinquished or curtailed in this process, and to ensure that gender imbalances are not being exacerbated.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. UKTUS activity codes attributed to compositional parts.

Activity Code	Compositional Part
0 Unspecified personal care	Personal care
110 Sleep	Sleep
111 Sleep: in bed not asleep	Sleep (unless secondary activity, e.g., reading, watching television in which case coded to the relevant component)
120 Sleep: Sick in bed	
210 Eating	Eating
300 Other personal care: unspecified other personal care	Personal care
310 Other personal care: wash and dress	
390 Other personal care: other specified personal care	
1000 Unspecified employment	Work
1100 Main job: unspecified main job	
1110 Main job: working time in main job	
1120 Main job: coffee and other breaks in main job	
1200 Second job: unspecified second job	
1210 Second job: working time in second job	
1220 Second job: coffee and other breaks in second job	
1300 Activities related to employment: unspecified activities related to employment	
1310 Activities related to employment: lunch break	
1390 Activities related to employment: other specified activities related to employment	
1391 Activities related to employment: activities related to job seeking	
1399 Activities related to employment: other specified activities related to employment	
2000 Study: unspecified study school or university	
2100 Study: unspecified activities related to school or university	Work
2110 Study: classes and lectures	
2120 Study: homework	
2190 Study: other specified activities related to school or university	
2210 Free time study	
3000 Unspecified household and family care	
3100 Unspecified food management	
3110 Food preparation and baking	
3130 Dish washing	
3140 Preserving	
3190 Other specified food management	
3200 Unspecified household upkeep	

Table A1. *Cont.*

Activity Code	Compositional Part
3210 Cleaning dwelling	
3220 Cleaning yard	
3230 Heating and water	
3240 Arranging household goods and materials	
3250 Disposal of waste	
3290 Other or unspecified household upkeep	
3300 Unspecified making and care for textiles	
3310 Laundry	
3320 Ironing	
3330 Handicraft and producing textiles	
3390 Other specified making and care for textiles	
3410 Gardening	
3420 Tending domestic animals	
3430 Caring for pets	
3440 Walking the dog	
3490 Other specified gardening and pet care	
3500 Unspecified construction and repairs	
3510 House construction and renovation	
3520 Repairs of dwelling	
3530 Making repairing and maintaining equipment	
3531 Woodcraft, metalcraft, sculpture, and pottery	
3539 Other specified making, repairing, and maintaining equipment	
3540 Vehicle maintenance	
3590 Other specified construction and repairs	
3600 Unspecified shopping and services	
3610 Unspecified shopping	
3611 Shopping mainly for food	
3612 Shopping mainly for clothing	
3613 Shopping mainly related to accommodation	
3614 Shopping or browsing at car boot sales or antique fairs	Socialising and hobbies
3615 Window shopping or other shopping as leisure	Socialising and hobbies
3619 Other specified shopping	Work
3620 Commercial and administrative services	
3630 Personal services	
3690 Other specified shopping and services	
3710 Household management not using the internet	
3713 Shopping for and ordering clothing via the internet	

Table A1. *Cont.*

Activity Code	Compositional Part
3720 Unspecified household management using the internet	
3721 Shopping for and ordering unspecified goods and services via the internet	
3722 Shopping for and ordering food via the internet	
3724 Shopping for and ordering goods and services related to accommodation via the internet	
3725 Shopping for and ordering mass media via the internet	Leisure screen time
3726 Shopping for and ordering entertainment via the internet	
3727 Banking and bill paying via the internet	
3729 Other specified household management using the internet	
3800 Unspecified childcare	
3810 Unspecified physical care and supervision of a child	
3811 Feeding the child	
3819 Other and unspecified physical care and supervision of a child	
3820 Teaching the child	
3830 Reading playing and talking with child	
3840 Accompanying child	
3890 Other or unspecified childcare	Work
3910 Unspecified help to a non-dependent, e.g., injured adult household member	
3911 Physical care of a non-dependent, e.g., injured adult household member	
3914 Accompanying a non-dependent adult household member, e.g., to hospital	
3919 Other specified help to a non-dependent adult household member	
3920 Unspecified help to a dependent adult household member	
3921 Physical care of a dependent adult household member, e.g., Alzheimic parent	
3924 Accompanying a dependent adult household member, e.g., Alzheimic	
3929 Other specified help to a dependent adult household member	Work
4000 Unspecified volunteer work and meetings	
4100 Unspecified organisational work	
4110 Work for an organisation	Socialising and hobbies
4120 Volunteer work through an organisation	
4190 Other specified organisational work	

Table A1. *Cont.*

Activity Code	Compositional Part
4200 Unspecified informal help to other households	Work
4210 Food management as help to other households	
4220 Household upkeep as help to other households	
4230 Gardening and pet care as help to other households	
4240 Construction and repairs as help to other households	
4250 Shopping and services as help to other households	
4260 Help to other households in employment and farming	
4270 Unspecified childcare as help to other households	
4271 Physical care and supervision of child as help to another household	
4272 Teaching non-co-resident child	
4273 Reading playing and talking to non-co-resident child	
4274 Accompanying non-co-resident child	
4275 Physical care and supervision of own child as help to another household	
4276 Teaching own non-co-resident child	
4277 Reading playing and talking to own non-co-resident child	
4278 Accompanying own non-co-resident child	
4279 Other specified childcare as help to another household	
4280 Unspecified help to an adult of another household	
4281 Physical care and supervision of an adult as help to another household	
4282 Accompanying an adult as help to another household	
4283 Other specified help to an adult member of another household	
4289 Other specified informal help to another household	
4290 Other specified informal help	
4300 Unspecified participatory activities	Socialising and hobbies
4310 Meetings	
4320 Religious activities	
4390 Other specified participatory activities	Socialising and hobbies
5000 Unspecified social life and entertainment	
5100 Unspecified social life	
5110 Socialising with family	
5120 Visiting and receiving visitors	
5130 Celebrations	
5140 Telephone conversation	

Table A1. *Cont.*

Activity Code	Compositional Part
5190 Other specified social life	
5200 Unspecified entertainment and culture	
5210 Cinema	
5220 Unspecified theatre or concerts	
5221 Plays musicals or pantomimes	
5222 Opera operetta or light opera	
5223 Concerts or other performances of classical music	
5224 Live music other than classical concerts opera and musicals	
5225 Dance performances	
5229 Other specified theatre or concerts	
5230 Art exhibitions and museums	
5240 Unspecified library	
5241 Borrowing books records audiotapes videotapes CDs, DVDs etc. from a library	
5242 Reference to books and other library materials within a library	
5243 Using internet in the library	Leisure screen time
5244 Using computers in the library other than internet use	Socialising and hobbies
5245 Reading newspapers in a library	
5246 Listening to music in a library	
5249 Other specified library activities	
5250 Sports events	
5290 Unspecified entertainment and culture	
5291 Visiting a historical site	
5292 Visiting a wildlife site	
5293 Visiting a botanical site	
5294 Visiting a leisure park	
5295 Visiting an urban park playground designated play area	Physical activity
5299 Other or unspecified entertainment or culture	Socialising and hobbies
5310 Resting—Time out	Sleep
6000 Unspecified sports and outdoor activities	Physical activity
6100 Unspecified physical exercise	
6110 Walking and hiking	
6111 Taking a walk or hike that lasts at least 2 miles or 1 h	
6119 Other walk or hike	
6120 Jogging and running	
6130 Biking skiing and skating	
6131 Biking	

Table A1. *Cont.*

Activity Code	Compositional Part
6132 Skiing or skating	Physical activity
6140 Unspecified ball games	
6141 Indoor pairs or doubles games	
6142 Indoor team games	
6143 Outdoor pairs or doubles games	
6144 Outdoor team games	
6149 Other specified ball games	
6150 Gymnastics	
6160 Fitness	
6170 Unspecified water sports	
6171 Swimming	
6179 Other specified water sports	
6190 Other specified physical exercise	
6200 Unspecified productive exercise	
6210 Hunting and fishing	
6220 Picking berries mushroom and herbs	
6290 Other specified productive exercise	
6310 Unspecified sports related activities	
6311 Activities related to sports	
6312 Activities related to productive exercise	
7000 Unspecified hobbies games and computing	Leisure screen time
7100 Unspecified arts	Socialising and hobbies
7110 Unspecified visual arts	
7111 Painting drawing or other graphic arts	
7112 Making videos taking photographs or related photographic activities	
7119 Other specified visual arts	
7120 Unspecified performing arts	
7121 Singing or other musical activities	
7129 Other specified performing arts	
7130 Literary arts	
7140 Other specified arts	
7150 Unspecified hobbies	
7160 Collecting	
7170 Correspondence	
7190 Other specified or unspecified arts and hobbies	
7220 Computing: programming	Leisure screen time
7230 Unspecified information by computing	
7231 Information searching on the internet	

Table A1. *Cont.*

Activity Code	Compositional Part	
7239 Other specified information by computing		
7240 Unspecified communication by computer		
7241 Communication on the internet		
7249 Other specified communication by computing		
7250 Unspecified other computing		
7251 Skype or another video call	Socialising and hobbies	
7259 Other specified computing	Leisure screen time	
7300 Unspecified games		
7310 Solo games and play	Physical activity	
7320 Unspecified games and play with others		
7321 Billiards pool snooker or petanque		
7322 Chess and bridge	Physical activity	
7329 Other specified parlour games and play		
7330 Computer games	Leisure screen time	
7340 Gambling		
7390 Other specified games		
8000 Unspecified mass media		
8100 Unspecified reading	Socialising and hobbies	
8110 Reading periodicals		
8120 Reading books		
8190 Other specified reading		
8210 Unspecified TV video or DVD watching		
8211 Watching a film on TV		
8212 Watching sport on TV		
8219 Other specified TV watching	Leisure screen time	
8220 Unspecified video watching		
8221 Watching a film on video		
8222 Watching sport on video		
8229 Other specified video watching		
8300 Unspecified listening to radio and music		
8310 Unspecified radio listening		
8311 Listening to music on the radio	Socialising and hobbies	
8312 Listening to sport on the radio		
8319 Other specified radio listening		
8320 Listening to recordings		
9000 Travel related to unspecified time use		
9010 Travel related to personal business		
9100 Travel to/from work	Work	Unless travelling by foot or bicycle, in which case time was coded to physical activity
9110 Travel in the course of work		
9120 Travel to work from home and back only		

Table A1. *Cont.*

Activity Code	Compositional Part	
9130 Travel to work from a place other than home		
9210 Travel related to education		
9230 Travel escorting to/from education		
9310 Travel related to household care		
9360 Travel related to shopping		
9370 Travel related to services		
9380 Travel escorting a child other than education		
9390 Travel escorting an adult other than education		
9400 Travel related to organisational work	Physical activity	
9410 Travel related to voluntary work and meetings		
9420 Travel related to informal help to other households		
9430 Travel related to religious activities		
9440 Travel related to participatory activities other than religious activities		
9500 Travel to visit friends/relatives in their homes not respondent's household		
9510 Travel related to other social activities	Physical activity	Unless travelling by foot or bicycle, in which case time was coded to physical activity
9520 Travel related to entertainment and culture		
9600 Travel related to other leisure		
9610 Travel related to physical exercise		
9620 Travel related to hunting and fishing		
9630 Travel related to productive exercise other than hunting and fishing		
9710 Travel related to gambling	Socialising and hobbies	
9720 Travel related to hobbies other than gambling		
9800 Travel related to changing locality		
9810 Travel to holiday base		
9820 Travel for day trip/just walk		
9890 Other specified travel	Work	
9940 Punctuating activity	Work	
9950 Filling in the time-use diary		

Appendix B

The most common pattern of time-use composition saw individuals reporting doing all activities (34%), then all activities except physical activity (32%), then all activities except physical activities and hobbies/socialising (9%). For physical activity, there were a large number of zero values (51% of participants). For other activity categories, there were a smaller number of zero values: 21% for hobbies and socialising, 11% for leisure screen time, 4% for other personal care, 4% for eating, and 3% for nondiscretionary activities. There were no zero values for sleep, as diaries reporting zero minutes of sleep were excluded in the quality control procedures.

Appendix C

The numerical values behind Figures 1–3 are presented below in Tables A2–A4.

Table A2. Model-adjusted compositional means (mins/day) by foodwork category for whole sample and population subgroups.

Parts	Whole Sample			Gender						Employment Status					
				Men			Women			Active			Inactive		
	None	Some	More	None	Some	More	None	Some	More	None	Some	More	None	Some	More
Personal Care	79.43	74.03	66.67	67.83	67.79	63.29	97.53	81.10	73.71	73.19	70.92	63.78	84.41	76.73	72.81
Sleep	764.98	679.87	614.19	759.69	683.58	625.17	775.31	675.30	606.12	736.47	680.60	644.18	798.45	688.69	607.92
Eating	108.09	88.51	83.80	113.22	90.75	85.09	100.97	86.35	81.62	94.05	78.44	78.56	125.01	103.78	93.65
Physical Activity	13.34	16.15	15.29	16.47	18.68	16.83	10.66	14.16	13.69	12.10	14.82	13.64	12.70	15.51	15.47
Leisure Screen Time	128.65	148.41	139.62	157.65	173.39	158.73	103.37	126.40	121.47	124.33	147.68	151.53	158.13	175.45	148.86
Work	263.66	345.46	447.45	249.50	315.02	412.52	256.29	370.50	473.12	335.23	370.67	421.28	127.90	256.76	403.08
Socialising and Hobbies	81.84	87.58	72.99	75.65	90.79	78.38	95.88	86.20	70.28	64.64	76.88	67.02	133.40	123.09	98.20

Table A3. Log-ratio difference between groups and bootstrapped confidence intervals.

Parts	Whole Sample				Gender							
					Men				Women			
	Some vs. None		More vs. Some		Some vs. None		More vs. Some		Some vs. None		More vs. Some	
	LR [a]	CI [b]	LR	CI	LR	CI	LR	CI	LR	CI	LR	CI
Personal Care	−0.06	−0.14, 0.01	**−0.09**	**−0.15, −0.03**	0.01	−0.09, 0.11	−0.07	−0.17, 0.03	**−0.17**	**−0.29, −0.05**	**−0.09**	**−0.17, −0.02**
Sleep	**−0.12**	**−0.14, −0.09**	**−0.09**	**−0.11, −0.07**	**−0.10**	**−0.13, −0.07**	**−0.08**	**−0.11, −0.05**	**−0.13**	**−0.17, −0.09**	**−0.10**	**−0.12, −0.07**
Eating	**−0.20**	**−0.27, −0.13**	−0.05	−0.11, 0.00	**−0.23**	**−0.31, −0.14**	−0.06	−0.15, 0.03	**−0.15**	**−0.27, −0.04**	−0.05	−0.13, 0.02
Physical Activity	**0.19**	**0.03, 0.35**	−0.03	−0.17, 0.10	0.11	−0.10, 0.33	−0.06	−0.28, 0.15	**0.30**	**0.05, 0.55**	−0.02	−0.19, 0.16
Leisure Screen Time	**0.14**	**0.03, 0.25**	−0.05	−0.13, 0.03	0.08	−0.05, 0.21	−0.07	−0.20, 0.05	**0.21**	**0.02, 0.39**	−0.03	−0.14, 0.08
Work	**0.27**	**0.19, 0.36**	**0.23**	**0.18, 0.27**	**0.24**	**0.13, 0.36**	**0.22**	**0.16, 0.35**	**0.35**	**0.22, 0.49**	**0.23**	**0.17, 0.28**
Socialising and Hobbies	0.08	−0.06, 0.22	**−0.17**	**−0.28, −0.06**	0.17	0.00, 0.34	−0.12	−0.31, 0.05	−0.09	−0.30, 0.13	**−0.20**	**−0.34, −0.07**

[a] LR = Log-ratio difference between foodwork categories, bold font signifies a statistically significant difference ($p < 0.017$). Log-ratio differences are difficult to interpret numerically, and, in the text, they are just presented as significantly higher or significantly lower. Numerically, a 'significant' difference is one where the confidence interval does not cross 0, the natural log of 1, indicating a ratio between equal proportions. Significant differences that are over 0 may be interpreted as significantly higher than the reference category, and significant differences that are under 0 may be interpreted as significantly lower than the reference category. [b] CI = 98.3% confidence intervals constructed using a bootstrap technique; critical level was adjusted from 0.05 to 0.017 using the Bonferroni correction.

Table A4. Log-ratio difference between groups and bootstrapped confidence intervals.

Parts	Employment Status							
	Active				Inactive			
	Some vs. None		More vs. Some		Some vs. None		More vs. Some	
	LR	CI	LR	CI	LR	CI	LR	CI
Personal Care	−0.03	−0.12, 0.06	**−0.09**	**−0.17, −0.01**	−0.09	−0.24, 0.05	−0.03	−0.14, 0.06
Sleep	**−0.07**	**−0.10, −0.05**	**−0.05**	**−0.08, −0.03**	**−0.15**	**−0.20, −0.11**	**−0.11**	**−0.14, −0.08**
Eating	**−0.18**	**−0.27, −0.09**	0.00	−0.07, 0.08	**−0.20**	**−0.31, −0.08**	**−0.10**	**−0.19, −0.02**
Physical Activity	0.20	0.00, 0.41	−0.06	−0.24, 0.12	0.19	−0.07, 0.45	0.01	−0.20, 0.21
Leisure Screen Time	**0.17**	**0.04, 0.30**	0.03	−0.08, 0.14	0.10	−0.08, 0.29	**−0.16**	**−0.28, −0.04**
Work	**0.10**	**0.01, 0.19**	**0.11**	**0.06, 0.16**	**0.68**	**0.50, 0.86**	**0.44**	**0.37, 0.51**
Socialising and Hobbies	0.17	−0.01, 0.34	−0.11	−0.26, 0.04	−0.07	−0.28, 0.15	**−0.24**	**−0.39, −0.08**

[a] LR = Log-ratio difference between foodwork categories, bold font signifies a statistically significant difference ($p < 0.017$). Log-ratio differences are difficult to interpret numerically, and, in the text, they are just presented as significantly higher or significantly lower. Numerically, a 'significant' difference is one where the confidence interval does not cross 0, the natural log of 1, indicating a ratio between equal proportions. Significant differences that are over 0 may be interpreted as significantly higher than the reference category, and significant differences that are under 0 may be interpreted as significantly lower than the reference category. [b] CI = 98.3% confidence intervals constructed using a bootstrap technique; critical level was adjusted from 0.05 to 0.017 using the Bonferroni correction.

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