

Association Between Intake of Ultra-Processed Food and Hours Worked: An Analysis of 2015-2018 NHANES

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ABSTRACT

Ultra-processed foods (UPFs) are foods that are typically ready-to-heat or eat and usually contain additives and substances not commonly used in food preparation. They make up around 60% of caloric intake in the US, but research has linked them with numerous detrimental effects on humans. This paper investigated the association between the number of hours worked per week and UPF consumption in the US to determine if addressing hours worked could potentially limit UPF intake. Though researchers have identified consequences of frequent UPF intake, not much is known about its possible causes. Using 2015-2018 NHANES data, ordinal logistic regression was performed to examine the relationship of interest. The major findings were that (1) UPFs contributed to around 65.2% of daily caloric intake in the US, and (2) there was no significant relationship between hours worked and UPF consumption. The high percent contribution reveals that UPFs make up a significant portion of American diets, and the observed lack of association aligns with previous findings that hours worked may not significantly impact feelings of time pressure (and resulting food choices). However, these analyses are limited in that NHANES does not categorize foods as UPF/non-UPF beforehand and potentially influential variables that were not asked about could not be accounted for. Overall, the high rate of consumption reinforces the need for more research about UPF intake reduction strategies, and the non-significant relationship of interest suggests that hours worked may not be an effective variable to analyze for its impact on UPF consumption.

Introduction

With the continual development of food processing technologies, the relative dietary contribution and overall consumption of ultra-processed foods (UPFs) have increased over time in the United States.¹ Currently, they make up around 60% of Americans' daily caloric intake.^{1,2}

Ultra-processed foods are defined as food products that require little to no preparation before consuming and usually contain additives such as sugars, fats, stabilizers, and preservatives. Furthermore, substances not typically used for food preparation (e.g., direct extracts from food (lactose, whey), hydrogenated oils, artificial sweeteners, emulsifiers) are often added to mimic sensory qualities of unprocessed foods or to disguise unpalatable sensory characteristics.³ Many foods traditionally seen as junk foods are considered UPFs, such as frozen pizzas, fish sticks, and hot dogs, though other items such as breakfast cereals, fruit drinks, granola bars, and infant formulas also fall into this category.³

The term was first coined by developers of NOVA, which is a four-group classification system based on the degree and purpose of food processing. The groups are arranged from least to most processed: unprocessed/minimally processed foods (group 1), processed culinary ingredients (group 2), processed foods (group 3), and ultra-processed foods (group 4).³

Though UPFs contribute heavily to Americans' caloric intake, studies have found that they are associated with many negative health effects. UPFs tend to be energy-dense due to their main ingredients (often saturated or trans fats, salt, and/or sugars) and their lack of dietary fiber and water.⁴ Because people sense the volume of food eaten better than the energetic content,⁵ they are more likely to consume excessive calories in the form of UPFs, which could result in weight gain. Findings from a study performed by Filippa Juul⁵, a researcher with a PhD in public health, and her colleagues support this idea: in a nationally representative sample of the US, increased UPF consumption was significantly associated with greater BMI and waist circumference and higher odds of being overweight or obese.

Furthermore, UPFs constitute nearly all (89.7%) of Americans' daily added sugar intake.² Added sugars are empty calories, providing very little nutritional value, so consuming them instead of more nutritious foods can lead to "simultaneously overfed and undernourished individuals".² They are also correlated with multiple diseases and health conditions such as obesity, type 2 diabetes mellitus, coronary heart disease, and cavities.² Thus, because frequent consumption of added sugars is detrimental to human health, so is frequent consumption of UPFs.

Another way UPFs can damage human bodies is through possible harmful compound exposure from the packaging or from the food itself. For instance, polyfluoroalkyl substances can be found in food packaging. As the Environmental Protection Agency, a US federal government agency responsible for protecting the health of people and of the environment, states, these substances tend to stay in the body for a long time, and increased accumulation may lead to higher cholesterol levels or a weakened immune system.⁶ Other compounds like acrylamide and polycyclic aromatic hydrocarbons are carcinogens and are formed during processing methods that involve heat.⁷⁻¹⁰ Interaction with or even consumption of these unsafe chemicals may have contributed to the significant association between high UPF consumption and greater mortality risk found by Hyunju Kim⁷ and her colleagues.

In addition to their adverse impacts on human health, UPFs pose a risk to environmental protection, social interaction, and cultural preservation. From an environmental standpoint, transporting the products may require long-distance travel, which involves significant usage of non-renewable energy, and the single-use packaging is often just thrown away, contributing to litter and increased build-up in landfills.⁴ In terms of social relationships, UPFs make it easier for people to eat a quick meal on the go or by themselves, so they will be less likely to eat home-prepared meals together with family.⁴ A study conducted by Peeter Verlegh,¹¹ the head professor of marketing at Vrije Universiteit Amsterdam, corroborates this with its finding that people are more likely to eat TV dinners (a type of UPF) alone than with family and friends. UPFs can also undermine national and local cultures by replacing traditional foods⁴ since ultra-processed items are hyper-palatable and easier to prepare.

Literature Review

Relationship between convenience and UPF intake

Convenience is commonly identified as a factor contributing to the growing prevalence of UPFs^{3,4,12-16}: ultra-processed products are typically ready-to-heat or eat, allowing consumers to quickly prepare a meal even without a fully functional kitchen, and are usually shelf or freezer stable, so they can be kept for longer.¹⁶ Such characteristics mean choosing to consume UPFs instead of cooking meals from scratch drastically reduces the amount of time and effort needed to prepare meals, making UPFs appealing to many types of consumers. This idea is further supported by studies that specifically assess the relationship between time-related factors and UPF or convenience food intake.

Djupegot et al¹³ looked at the association between time scarcity—subjective feelings of time pressure—and UPF consumption (using the NOVA framework) in Norwegian parents. They found a positive association between time scarcity and intake of ultra-processed dinner items, snacks, and soft drinks, concluding that "the consumption of ready meals is used as a strategy for better time management".¹³ However, the study used a non-validated survey approach, so the results may not be representative of the entire country.

Slater et al¹⁴ examined the effects of perceived time pressure by interviewing middle-income Canadian mothers to determine how it affected their food choices. The lack of time strongly influenced food preparation decisions: the mothers often felt like they didn't have time to make healthy or enjoyable food due to their jobs and their children's extracurricular activities and, as a result, had to rely on strategies that "got the food on the table, produced minimum negative response from family members and reduced the amount of time spent preparing the food".¹⁴ This frequently meant turning to restaurant take-away or convenience foods like frozen chicken fingers, Pizza Pops, and tinned pasta¹⁴ (all of which are UPFs).

Another group of researchers from the University of Auckland administered a similarly qualitative interview of 11 mothers in Auckland, New Zealand. Like the previous study, it identifies feelings of time pressure as a major constraint on the women's ability to prepare food. The authors assert that "the greater the perceived time pressures, the greater the likelihood of seeking convenience in food provisioning",¹⁵ particularly for employed women. Examples of foods stored in anticipation of situations with limited time include frozen hot dogs, fish fingers, and oven chips¹⁵ (all UPFs).

Though the aforementioned sources evaluated subjective feelings of time scarcity, Verlegh and Candel¹¹ used the quantitative metric of 'number of hours worked per week' instead. Adjusted statistical analyses of survey data from the Netherlands revealed a positive correlation between the frequency of TV dinner consumption and the number of hours worked by the household member in charge of meal preparation. Respondents with paid jobs also tended to eat TV dinners more often.¹¹ Interestingly, the authors compare their results to those from US studies by pointing out a societal difference between the two countries: in the US, restaurant options are plentiful and therefore compete with convenience foods in terms of ease and accessibility, but in the Netherlands, eating at restaurants is more expensive and often reserved for special occasions,¹¹ so citizens are more likely to turn to convenience foods (instead of restaurants) when pressed for time. The study's narrow focus on TV dinners limits its applicability, though it provides valuable support for the direct correlation between time availability and intake of ready-to-prepare food.

All of these sources illustrate how time-related factors have a significant impact on ultra-processed or convenience food consumption: decreased time availability and increased time pressure due to responsibilities like work or childcare create a need for quick, efficient ways to prepare meals. Because UPFs provide attractive, hyper-palatable food options that can be prepared quickly and with minimum effort,^{3,4} these findings also support the viability of looking at the number of hours worked (a measure of time availability) as a possible influencing factor of UPF consumption.

How this work differs from previous research

Some studies have identified negative consequences associated with increased UPF intake,^{2,4,5,7} but relatively few have looked at characteristics of UPFs that may contribute to the growing consumption issue. Examining possible causes instead of effects may help experts develop more effective solutions to the problem, so this paper analyzes the relationship between the number of hours worked per week and UPF intake in the US, where more than half of citizens' daily caloric intake comes from UPFs. Based on previous findings about convenience foods and time availability,^{11,13-15} the hypothesis was that there would be a positive correlation.

The dietary and occupational data was sourced from the two most recent cycles of the National Health and Nutrition Examination Survey (NHANES), a continuous, nationally representative survey conducted by The National Center for Health Statistics. Incorporating these details leads to the formal research question: Looking at NHANES data from 2015-2018, what type of association (if any) exists between the intake of ultra-processed foods and the number of hours worked each week among US adults 20 years and older?

This work differs from previously conducted studies about time and ultra-processed or convenience food because it includes a clear definition of ultra-processed foods, is conducted in the US, and is nationally representative.

The most notable difference is that this paper provides a detailed definition of ultra-processed food instead of simply using the general term "convenience food". Many existing studies include definitions of "convenience food"

with varying degrees of specificity and inclusivity—all but one of the sources in the literature review did not provide a concrete or universal definition (the paper by Djupegot et al¹³ used UPF) even though they frequently utilized the phrase. The lack of a clear definition may weaken their relevance to other studies and create confusion around what types of food count as convenience foods. On the other hand, this paper defines UPF using the NOVA classification framework, which has been recognized as a valid tool by the Food and Agriculture Organization and the Pan American Health Organization.³ Using a validated classification method is advantageous because it improves the credibility of the study and other researchers will be able to refer to a concrete definition of UPF. This also makes it possible to juxtapose these findings with those of other papers to form a more comprehensive profile of UPFs.

Furthermore, the global prevalence of UPFs means researchers from many different countries have studied them, but different countries have distinct societal norms that may influence UPF intake. Therefore, findings from one country may not hold true in another (as exemplified by Verlegh and Candel's¹¹ acknowledgement of different attitudes toward restaurants in the Netherlands and the US), and it seems that no other studies have used NHANES data to compare UPF and working hours.

Lastly, data from the NHANES is nationally representative, so the results can be generalized to a larger US population. In comparison, findings from most studies about this topic are limited in their applicability or scope, often due to their small sample size^{14,15} or unvalidated survey approach.^{11,13}

Since the goal is to assess the relationship between two variables, a correlational study was conducted using statistical analysis software. The NHANES does not specify if foods are ultra-processed or not, so the dietary data was first categorized based on guidelines from other studies and the official NOVA definition. The association between UPF consumption and weekly hours worked was then evaluated through ordinal logistic regression in RStudio.

Methods

Data source

The research data came from NHANES, a cross-sectional survey that uses a complex, multi-stage sampling design to select participants representative of the noninstitutionalized, civilian US population.¹⁷ All surveyed individuals gave signed consent. Analyses included publicly released data from two survey cycles, 2015-16 and 2017-18, instead of just one in order to reduce any error from nonresponse¹⁸ and obtain more reliable results.¹⁷

All participants completed a sample person questionnaire in the at-home interview component under the guidance of a trained interviewer. This included questions about demographic characteristics and occupation, as well as a 24-hour dietary recall that asked about all the foods and beverages the individual had consumed during the previous day.¹⁷

A total of 19,225 people responded to the at-home interview, and 16,147 people had complete data for the first dietary recall. Though the NHANES conducted two 24-hour dietary recalls—one during the at-home interview and the other by phone 3-10 days later—fewer participants completed the second one. In order to increase the final study sample size and produce more precise results, data from the second dietary recall was not used.

Variables of interest

The number of hours worked per week was treated as the explanatory variable because people are more likely to adjust their schedules and decisions based on how many hours they work (instead of the other way around). The cut-off for this variable was a maximum of 80 hours per week and a minimum of 5 hours per week (participants who did not have a job or worked 0 hours the previous week were assigned a “missing” value and were not included in final analyses).

The response variable was UPF consumption, which was measured by the percent contribution of UPFs to an individual's daily caloric intake. Because NHANES does not classify foods based on the NOVA system, the variable "USDA food code" in the dietary data was used to classify UPFs. Each food code is associated with a "Main food description" and "Additional food description" in the USDA Food and Nutrient Database for Dietary Studies,¹⁹ so each food item was matched with its corresponding descriptions. Using these descriptions, classifications made by other researchers,^{1,2,5} and the official NOVA guidelines,³ each food was labeled as either a UPF or a non-UPF. After this, items were re-classified as UPF if they had a combination food type of "Frozen meals" or "Lunchables" (under the "Combination food type" NHANES variable) or were sourced from a "Restaurant fast food/pizza" or "Vending machine" (under the "Food Source" variable) to increase the accuracy of the classifications. This procedure was suggested by Juul et al⁵ and is in accordance with NOVA guidelines. Some examples of food classified as UPF and non-UPF can be found in **Appendix 1**. Lastly, to determine UPF energy contribution, caloric values in the NHANES variable "Energy (kcal)" were summed for UPFs only, then divided by the total caloric intake for each individual.

Covariates

The covariates (other variables that may influence UPF consumption) of interest in this study were age, family income to poverty ratio (calculated by dividing family income by corresponding poverty guidelines from the Department of Health and Human Services), gender, race/ethnicity, and educational level. Age and family income to poverty ratio were measured as quantitative variables, while gender (categories: 'male', 'female'), race/ethnicity ('non-Hispanic white', 'non-Hispanic black', 'non-Hispanic Asian', 'Mexican American', 'other Hispanic', and 'other race, including multi-racial'), and educational level ('less than 9th grade', '9-11th grade, including 12th grade with no diploma', 'high school graduate/GED or equivalent', 'some college or AA degree', and 'college graduate or above') were categorical.

Final study sample

Of the 19,225 people surveyed in the two NHANES cycles, 5,673 had complete information for both hours worked and the first dietary recall. The sample was further limited to participants 20 years and older because educational level, one of the covariates, had different categories for those younger than 20, so adjusting for it would have been difficult. Those with missing data for other covariates were also excluded, resulting in a final sample size of 4,808 people.

Statistical analysis

Correlational research was performed to analyze the relationship between hours worked per week and UPF consumption. Though factor analysis, which involves multiple explanatory and response variables, was considered, this paper ultimately focuses on just one explanatory and one response variable. Therefore, correlational analysis, which utilizes only two main variables, was the most effective way to achieve the purpose of this research.

For descriptive statistics, the weighted mean and standard error of quantitative variables and the weighted mean percent of each category for categorical variables was calculated.

Weighted and adjusted ordinal logistic regression was then performed to assess the strength of the association between hours worked per week and UPF energy contribution. Though the original plan was to use linear regression, the data did not meet fundamental assumptions of that method and would have produced unusable results, so ordinal logistic regression was chosen instead, which still allowed for analysis of the correlation and covariate adjustment. In order to perform the regression, UPF contribution (which was originally a continuous variable) was split into weighted quintiles (in other words, the data was divided into five categories that contained roughly equal percentages of the sample). One benefit of ordinal logistic regression was that the categories of the response variable could be ordered (quintile 1 < quintile 2 for UPF consumption, and so on), which retains more information from the original data than

similar methods like multinomial regression. The odds ratio and 95% confidence interval for working hours and UPF energy contribution were calculated with the regression model output.

In order to adjust for nonresponse and make findings nationally representative, four-year sample weights (which reflect the number of people in the US population a surveyed individual represents) were created from the dietary data. In addition, due to the complex sampling design of NHANES, variance estimation was calculated with the Taylor Series Linearization method, which produced reliable and approximately unbiased estimates of sampling error.

All statistical analyses were performed in RStudio (which is free to use), primarily with the ‘*survey*’ package.

Limitations

The dietary recall data is limited in that a report of the previous 24 hours may not always reflect what an individual usually eats. However, the NHANES uses the Automated Multiple-Pass Method (AMPM) to collect dietary data, which has been validated by other researchers and shown to reduce bias.^{20,21}

The administration of the questionnaire by an interviewer may have also introduced bias if the participant altered their answer to appear more socially acceptable in front of another person. Lafay et al²² found that individuals are more likely to underreport consumption of foods viewed as “unhealthy” (such as French fries and cake), which are often UPFs. This could lead to an underestimate of UPF consumption.

Furthermore, some error may have resulted from misclassifications, particularly because NOVA guidelines were not written specifically for NHANES dietary data. The lack of specificity in food code descriptions contributed to this: for example, the type of meat in “egg omelet, with meat” was not specified for each entry, though possible options like ham, sausage, pork, and fish were listed. Some of the options (e.g., sausage) were UPFs, while others were not. In cases like these, the food was labeled as non-UPF because the main food (e.g., the egg omelet) was not a UPF. Similarly, when non-UPFs such as vegetables were cooked with margarine (a UPF), they were labeled as non-UPF since the vegetable was listed as the main food. Both of these classification choices would cause an underestimation of UPF energy contribution. However, because it is improbable that people would add large amounts of things like margarine to food (so that there is more margarine than the original food) and because this paper examines the overall correlation between hours worked and UPF consumption, the underestimation might not have strongly impacted any relationships between the two variables.

Results

Descriptive statistics

As seen in **Table 1**, the mean UPF energy contribution from 2015-2018 was 65.2%, which is higher than values calculated for previous NHANES cycles: 57.9% from 2009-2010,² 56.1% from 2005-2014,⁵ and 58.5% from 2007-2012.¹ The variation in values may have been affected by classification differences—though NOVA provides specific definitions and product examples for the four food groups, there are no specialized guidelines for categorizing NHANES data. However, because the method followed classifications made by other researchers^{1,2,5} (some of the paper authors were also original founders of NOVA) and the official NOVA guidelines when possible, these results still demonstrate that UPFs make up a significant portion of Americans’ diets.

In addition, the mean number of hours worked per week was 40.5, which is reasonable based on the Fair Labor Standards Act of 1938’s guideline that 40 hours of work constitutes a regular workweek.²³

Table 1. Descriptive statistics of the sample of interest (n = 4,808). Weighted means and standard errors are reported for quantitative variables, and unweighted counts, weighted mean percentages, and standard errors are reported for categorical variables.

	Weighted mean	Standard error	
VARIABLES OF INTEREST			
Hours worked per week	40.480	0.400	
UPF energy contribution (%)	65.217	0.608	
QUANTITATIVE COVARIATES			
Age (years)	42.032	0.370	
Family income to poverty ratio	3.267	0.055	
	Unweighted counts	Weighted mean percent (%)	Standard error
CATEGORICAL COVARIATES			
Gender			
Male	2514	53.397	1.060
Female	2294	46.603	1.060
Race/ethnicity			
Non-Hispanic White	1587	62.593	2.450
Non-Hispanic Black	1088	11.109	1.360
Non-Hispanic Asian	650	5.962	0.800
Mexican American	772	9.777	1.500
Other Hispanic	510	6.361	0.760
Other race, including multi-racial	201	4.197	0.450
Educational level			
< 9 th grade	303	2.962	0.490
9-11 th grade (including 12 th grade with no high school diploma)	445	6.172	0.550
High school graduate/GED or equivalent	1028	22.773	1.230
Some college or AA degree	1610	33.554	1.130
College graduate or above	1422	34.538	2.200

To get a general idea of what the relationship between the two variables looked like, the data was first graphed in RStudio, with hours worked per week as the explanatory variable (x-axis) and percent UPF energy contribution as the response variable (y-axis). The size of each hexagon in **Figure 1** corresponds with its sample weight, which also reflects how much a person's responses will affect the results.

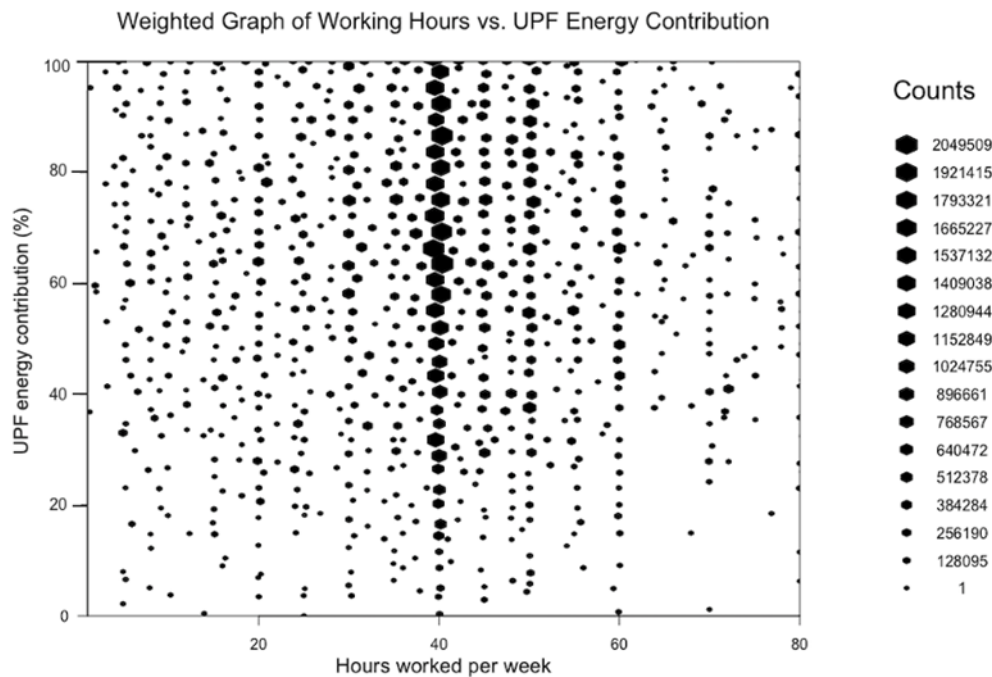


Figure 1. Weighted scatterplot of hours worked per week (x) vs. % UPF energy contribution (y). The size of each hexagon reflects the individual's sample weight.

Ordinal logistic regression

The preliminary scatterplot did not seem to suggest a strong linear association between the variables, but to test the hypothesized correlation more reliably, weighted ordinal logistic regression with the UPF quintiles was performed, adjusting for the identified covariates. The odds of being in a higher UPF contribution quintile (as opposed to a lower one) were found to be 1.002066 greater (they increase by 0.2066%) for each one-hour increase in hours worked per week, given that the other variables in the model are held constant. However, the 95% confidence interval for the odds ratio (seen in **Table 2**) contains 1, which essentially means that working more hours is not associated with higher UPF energy contribution.

Table 2. Weighted and adjusted (for covariates) ordinal logistic regression output.

Explanatory variable	Ordered response variable	Odds Ratio	95% Confidence Interval
Hours worked per week	UPF energy contribution (quintiles)	1.0020660	(0.9957303, 1.0084420)

Overall, both the scatterplot and adjusted regression results demonstrate that there is no significant correlation between hours worked and UPF consumption, disproving the original hypothesis.

Analysis

There are a couple of factors that could explain the lack of an observed association. Firstly, hours worked per week may not have been an effective variable to analyze. Sam et al,²⁴ who found no significant relationship between working hours and overall diet quality, eating out, and take-away consumption in the UK, suggest that increased work time (and decreased time for other responsibilities) does not necessarily mean people will *feel* like they have less time. As a result of their unaffected feelings of time scarcity, behaviors regarding food selection may not change. Applied in relation to this study, this means that even if someone works longer hours, they might not eat more UPFs out of convenience because they do not experience time pressure. This reasoning is supported by a US study that failed to find a significant association between hours worked and perceived time pressure among a sample of young adults.²⁵ The possibility that people respond to the same conditions of time pressure in different ways may therefore clarify why no significant association between hours worked and UPF consumption was found.

Despite this evidence, it was originally believed that there might be a correlation between the variables of interest due to Verlegh and Candel's¹¹ finding of a significant relationship between hours worked and TV dinner consumption. However, as previously mentioned, the societal differences between the Netherlands and the US likely contributed to their results. Their focus on the household member responsible for meal preparation is another important aspect, backed by reasoning from Sam et al²⁴ that working more hours may not affect the consumption choices of household members not in charge of cooking food. The research method used in this paper was unable to control for meal preparation duties, which may have led to the non-significant relationship between hours worked and UPF consumption.

The inability to control for all influencing variables presents another limitation of this work that may have altered the association. NHANES can feasibly obtain only a certain amount of data from participants, so factors that were not asked about in the survey could not be accounted for. In addition to food preparation responsibilities, potentially influential variables that this study could not adjust for include cooking skill and time spent sleeping, commuting, or taking care of children.

The prioritization of other qualities of UPFs over their convenience is also a possible reason for the observed lack of correlation. NOVA's original developers proposed other characteristics such as hyper-palatability, packaging, and intensive marketing that may make UPFs more attractive compared to unprocessed or minimally processed foods.^{3,4} If some consumers did not primarily value ease or speed of preparation when buying foods, then a strong relationship between a measure of convenience (e.g., hours worked) and UPF consumption would be less probable.

Conclusion

These findings suggest that there is no significant correlation between hours worked and UPF energy contribution among US adults and signal to other researchers in the field that the number of hours worked might not be an effective variable to analyze for its impact on UPF consumption, providing support for the claims made by Sam et al²⁴ about the lack of correlation between time availability and feelings of time pressure. However, because this work is only a single study done on a specific set of data, a definitive conclusion that no association exists between hours worked and UPF intake cannot be made, and it is recommended that other researchers confirm the lack of a relationship, possibly using different data or controlling for more variables. In addition, exploring the impacts of other aspects of time availability or convenience, particularly feelings of time pressure, on UPF consumption may yield different results.

This study also reveals that UPFs make up about 65.2% of daily caloric intake in the US, aligning with previous researchers' observations that UPFs still make up a significant portion of people's diets in the country. Considering the numerous detrimental impacts of UPFs on humans, the environment, and social/cultural relationships, further exploration of possible factors influencing their consumption is strongly recommended. Relatively few studies

have analyzed potential methods to reduce consumption like this paper did, despite growing evidence that UPFs harm multiple aspects of our lives and constitute a significant part of daily caloric intake in the US, resulting in a gap in the broader field of knowledge. Though this work has contributed information about the relationship between UPF intake and an aspect of convenience, it by no means eliminates the gap. A further step in this direction could be identifying what characteristics of UPFs consumers prioritize the most when buying them, then assessing how strongly each of those attributes affect consumption. If a relationship is identified, addressing or controlling that characteristic could be a potential strategy to reduce UPF intake.

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