Female Labor Force Participation and Diet Quality

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Abstract

Time is an import input for healthful food production. In this study, we look at the effect of female head's working hours on diet quality. Using comprehensive panel data of household food purchases, we find a 1%-1.3% decrease in the diet quality with a 10 hours increase in female head's working hours in the fixed effect model. To overcome the endogeneity of the female head labor supply, we implement the instrumental variable method using the eligibility of social security benefits as the instrument variable and focus on families with female heads aged 55-74. The results from the instrumental variable method show that diet quality decreases by 2.3%-4.5% for a 10 hours increase in female head's working hours. Furthermore, we find that the family with female head working more hours significantly reduce their trips to grocery shopping and switch their purchase from fruits and vegetables to frozen and prepared food.

Key words: Food Consumption; Diet Quality; Working Hours; Time Constraint
JEL codes: D12, I12, I18

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¶Researcher(s) own analyses calculated (or derived) based in part on data from The Nielsen Company (US), LLC and marketing databases provided through the Nielsen Datasets at the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business. The conclusions drawn from the Nielsen data are those of the researcher(s) and do not reflect the views of Nielsen. Nielsen is not responsible for, had no role in, and was not involved in analyzing and preparing the results reported herein.

1 Introduction

Obesity has been emerging as one of the most challenging public health issues in the United States (US) (Finkelstein & Strombotne, 2010; Ogden *et al.* , 2015). In the US, Obesity has increased by more than five-fold since the 1960s and currently, over 40% of the adult population is considered obese (Ogden *et al.* , 2015; Finkelstein & Strombotne, 2010; Revels *et al.* , 2017; Cawley *et al.* , 2021). It is well established that diet quality is a strong predictor of obesity (Bray & Popkin, 1998; Cavadini *et al.* , 2000; Chen *et al.* , 2016). Therefore, it is important to understand the determinants of households' diet choices.

A wave of recent studies has drawn increased attention to the key determinants of poor diet in the US. The existing body of literature highlights three behavioral and economic factors correlated with dietary choices: (1) income (budgets) - healthful foods are often more expensive; (2) availability - people may live in food deserts, where healthful foods are not available; and (3) preferences (Allcott *et al.* , 2019; Hut & Oster, 2022; Zhang *et al.* , 2022). While time is a crucial input to nutritional outcomes, few studies link it to poor diet quality in the US. This study aims to fill the gap and test whether female labor force participation impacts diet quality.

The current studies on the relationship between time allocation and diet quality mainly focus on the developing countries (Johnston *et al.* , 2018; Komatsu *et al.* , 2018; Sangwan & Kumar, 2021). Female labor force participation can affect diet quality through two major channels. First, as the female allocates more time from domestic work to paid work, the family income would increase so that family can afford more diverse and healthful food. Labor force participation would have a positive effect on the diet quality through the income effect. Second, as females spend more time on work and thus less time on food production, purchase, and preparation, the quality of diet could decrease. The empirical results are still mixed in the developing countries (Johnston *et al.* , 2018). Sangwan & Kumar (2021) show that diet quality improves when the female involves in paid work in rural India, suggesting the income effect dominates. Komatsu *et al.* (2018) find that the effect of female working hours on diet quality depends on the asset poverty status. For non-poor families, working hours is negatively associated with women's dietary diversity score, while it is positively associated for poor families.

Our study is different from the above literature in several ways. First, we focus on the US, which is a developed country, and investigate how differently the female labor force participation impacts the diet quality. Second, we use Nielsen Homescan panel data from 2004-2013 with comprehensive information on food purchases. Compared to the traditional survey data, the transaction-level purchase data can track households' food purchases more accurately. The panel structure of the data allows us to track the same household over time. Third, few studies have dealt with the endogeneity decision on female head's labor supply. We use the instrumental variable method to overcome the endogeneity and quantify the causal impact of working hours on diet quality.

The Nielsen panel data from 2004-2013, we use, contain detailed information on purchases at the household-day level, products at Universal Product Code (UPC) level, and demographics. As we have detailed product-level information on price and quality, we are able to construct price-based measures for diet quality using accurate price, quantity, and product information. In order to show the robustness of our results, we use three different ways to measure diet quality in our study. First, we create a simple share measure of household expenditure on fruits and vegetables; second, we generate a similar share measure based on total expenditure on healthful food; and third, we develop a composite index (USDAScore) constructed based on USDA guidelines.[1] USDAScore, introduced by Volpe *et al.* (2013), is used to measure the expenditure-share distance of each household's consumption from what USDA recommends. Our first two measures have been used in numerous studies, so we include them as a means of comparison with previous research; USDAScore provides a more complete picture of household food purchasing behavior, so we add it as a richer description of household dietary purchasing patterns and outcomes.

It is challenging to quantify the causal effect of female labor force participation on diet quality. The decision on the female's labor supply and working hours is endogenous. First of all, we use individual and time fixed effect (FE) model and control for rich demographics information. We are

[1]Healthful food includes fruits and vegetables, fruit juices, white meat, whole grains, low-fat milk and yogurt, nuts, and eggs.

able to analyze the within household variation in diet quality associated with female head working hours. The Nielsen data include rich information on demographics such as household structure, income, education level, age, and race. This information is updated on an annual basis so we are able to control for time-varying demographic effects. In addition to rich controls, the FE model is used widely to handle the bias from time-invariant omitted variables. For example, preference is omitted that female heads who value more health may work less and cook more healthful food at home. Given the preference is not likely to change in a short time, the FE model corrects the bias.

The results from our FE model show that reducing working hours has a significantly positive effect on diet quality. We find that the diet quality increases by 0.9%-1.3% when the female head are not working for payment and the diet quality decreases by 0.4%-0.5% if female heads work 10 more hours.

However, the estimation of the impact of female labor force participation on diet quality can still be biased even if we use the FE model and control for rich demographic information. The time-variant omitted variables could lead to biased estimation. For example, a sudden change on the wealth and family's health situation, which are not captured in the model, are directly related to both key independent variables, female working hours and diet quality. On one hand, a sudden increase in wealth could reduce the labor supply of the female head and increase the spending on healthful food, resulting in an overestimate on our estimator. On the other hand, a sudden worsened health of family members may force female heads to work less and pay more attention to diet quality, resulting in an underestimate of the effect. To overcome this potential endogeneity in female heads' labor force participation, we implement the fixed effect instrument variable(FE-IV) method. Following Hinnosaar (2018) and Smed *et al.* (2022), we use social security benefit eligibility as the instrument variable. Usually Americans are eligible for partial social security benefits at age 62 and full benefits at age 65. Around 31% Americans claim the benefits in their first month of eligibility and reduce their work hours (Fitzpatrick & Moore, 2018). We show that social security benefits eligibility significantly reduce the working hours and likelihood of working for payment. From the FE-IV model results, we find that the diet quality would decrease by 2.3%-

4.5% with a 10 hours increase in female head's working hours. The diet quality would improve by 9.8%-18.7% when female heads are not working for payment. The magnitudes of the impact is larger in the FE-IV model than that in the FE model. Therefore, both FE and FE-IV model show consistent results that female head's working hours have negative impact on the diet quality.

In addition, we test whether female labor force participation affect diet quality through time constraint. With more working hours, the female heads may spend less on food preparation. Specifically, they may go to grocery stores less frequently and purchase fewer fresh vegetables and fruits, as they are easily decayed. Instead, they would purchase more frozen and prepared food. We already show that female labor force participation would decrease the expenditure share in the above part. Using Nielsen Homescan panel data and the FE-IV method, we find the total counts of grocery shopping trips and days of grocery shopping increase by about 20% if the female head does not work for payment. Also, we find that the expenditure share for frozen and prepared food increases by about 5% with a 10 hours increase in working hours. Those results further support our test and hypothesis that the time constraint caused by more working hours for female heads of the family would result in lower quality of food.

Our results contribute to the literature in several ways. First, our study is directly related to the literature on female labor force participation, time use, and diet quality. Different from previous literature mainly focusing on developing countries, we focus on the US (Johnston *et al.* , 2018; Komatsu *et al.* , 2018; Sangwan & Kumar, 2021). We show that the female labor force participation reduces diet quality through the time constraint effect, while other studies in developing countries show that the income effect plays a more important role on how working for payment affect diet quality. There are some studies that examine this issue in the US from other angles. Hinnosaar (2018) examines the impact of retirement on healthful food purchases and finds that retirement would increase diet quality. Scharadin (2022) shows that dependent care deduction would reduce family's' childcare time and improves diet quality. Our study also shows that the diet quality would improve with more time allocated to food purchase, preparation, and cooking.

Second, our findings add to a growing body of work studying the determinants of dietary choice and diet quality (Volpe *et al.* , 2013; Dubois *et al.* , 2014; Marshall & Pires, 2017; Allcott *et al.* , 2019; Zhang *et al.* , 2022). Unlike previous literature focusing on food access, budget, and diet quality, this study examines the impact of female labor force participation on diet quality and check whether the higher labor force participation rate explains the poor diet. In the public health literature, a number of studies have shown that households with time constraints consume more unhealthful food (Jabs & Devine, 2006; Monsivais *et al.* , 2014).To date, most evidence shows that the scarcity of time for food preparation has negative effects on the healthfulness of food choices. Those studies mostly use cross-sectional data and their conclusion may not reflect a true causal effect. We attempt to fill this gap and use a more comprehensive longitudinal dataset allowing us to control for the individual fixed effect and yearly fixed effect. Moreover, to further examine the causal relationship between time constraints and diet quality using a longitudinal dataset we use the instrumental variable method.

Last, our study also sheds new light on the relationship between working hours and health. A series of studies conducted by Ruhm (Ruhm, 2000, 2003, 2005) show that recessions and higher unemployment rates are associated with better health, since households have less pressure, spend more time on exercises, and improve the diet. In addition, there is a large literature showing that retirement can affect health through physical activities, alcohol and cigarette consumption, and eating habit (Eibich, 2015; Fitzpatrick & Moore, 2018; Müller & Shaikh, 2018; Hinnosaar, 2018). Diet is one of the most important factors in these studies. The empirical results, however, are mixed. Our study specifically focuses on the relationship between working time and diet quality. We test whether reducing working hours can significantly improve the healthfulness of food purchases.

The remainder of the paper is structured as follows. In Section 2, we describe the consumption data and the construction of our outcomes variables, and in Section 3, we present the FE model and results. Section 4 presents the FE-IV method and results; Section 5 presents how the female head's working hours affect grocery shopping behaviors. Section 6 concludes.

2 Data

2.1 Household Food Consumption

Our primary source of household consumption data comes from the Nielsen HomeScan household panel for the years 2004-2013. The Nielsen HomeScan data are a nationally representative sample of household food purchasing behavior. Participants in the sample are asked to scan their daily purchases from supermarkets, convenience stores, mass merchandisers, club stores, and drug stores using at-home scanner technology. These data include household food purchasing information for approximately 40,000 households for the years 2004-2006 and over 60,000 households for the years 2007-2013. The data are drawn from over 20,000 zip codes across the US[2] The panel nature of these data allows us to track the purchases of households over time. The Nielsen data include rich information on demographics such as household structure, income, education level, age, and race. This information is updated on an annual basis so we are able to control for time-varying demographic effects. The most important feature of these data is that the data are at transnational level and they record the purchase information, including quantity, price, and product characteristics at UPC level, which are used to create our measures of diet quality.[3]

While these data provide a number of benefits, they also have limitations. Although Nielsen eliminates households that report only a small fraction of their expenditures, the dataset still contains some households who did not remain in the panel for a reasonable length of time or reported inconsistent or unreasonable purchases. Following Dubé *et al.* (2018), we apply multiple filters to the raw data to make them more reliable. First, we drop households that are in the data for less than six months; second, we drop households that do not spend at least $125 on food per quarter; third, we keep only households with a ratio of quarterly food consumption to family income greater than 0.1% and less than 200%; and finally, we exclude households with income less than $5000.

[2]We obtained these data via a cooperative agreement between Pennsylvania State University and Kilts Marketing Center at the University of Chicago.

[3]The data cover over 3,198,950 unique UPC from 1301 Nielsen product modules.

2.2 Variable Construction

2.2.1 Outcome Variables

To test the hypotheses in this paper, we construct our main outcome variable - a variable for diet quality, as It is challenging on to measure the diet quality accurately.

Following previous literature, we use three different measures of diet quality based on household-by-year expenditure shares. We begin by grouping 600 broad Nielsen food categories into 23 food groups based on the method in Volpe *et al.* (2013). From these 23 groups, we further divide them into healthful and unhealthful food classes based on the USDA Dietary Guidelines for Americans (DGA) and the Quarterly Food at-Home Price Database (Table 1). Using these groupings, we generate our first two measures of diet quality - expenditure share on fresh fruits and vegetables and expenditure share on all healthful food - using raw expenditure share data for each household and year. Expenditure shares on fruits and vegetables provide a simple way to measure diet quality, but only include two healthful food groups. So, we also create a second simple expenditure share measure based on the total share of food expenditure going to healthful foods. This provides a more complete measure of all healthful food consumption that is still based on raw expenditure shares.

For our final diet quality measure, we use USDAScore which is an index measure based on raw household expenditure outcomes and USDA dietary recommendations. It was introduced to the literature by Volpe *et al.* (2013) and has been widely used in a number of more recent studies (Chen *et al.* , 2016; Freedman & Kuhns, 2016; Allcott *et al.* , 2019). USDAScore measures the extent to which a households expenditure on a set of broad food categories deviates from recommendations from USDA's Center for Nutrition Policy and Promotion (CNPP).[4] Specifically, the USDA score

[4]The CNPP calculates food plans to assist Americans in allocating their food budgets to meet the dietary guidelines (Carlson *et al.* , 2007).

constructed for household h in time t is calculated as follows

$$USDAscore_{ht} = [\sum_{j \in J_{Healthful}} (Sh_{jht} - Sh_{jh}^{CNPP})^2 | Sh_{jht} < Sh_{jh}^{CNPP} \\ + \sum_{j \in J_{Unhealthful}} (Sh_{jht} - Sh_{jh}^{CNPP})^2 | Sh_{jht} > Sh_{jh}^{CNPP}]^{-1},$$

where j represents the CNPP food categories, Sh_{jht} denotes the percent of household h's food expenditures in quarter t on products in category j, and Sh_{jh}^{CNPP} is the expenditure share of category j that the CNPP recommends for household h.

To construct the recommended expenditure shares for each household, we need to covevrt the individual-level recommended shares to household-level shares. As the total expenditures for adults and children are different, we cannot treat them equally when we combine the recommended expenditures. Therefore, we assign a larger weight to adults and a smaller weight to children. Following Allcott *et al.* (2019), we use the OECD equivalence scale. Thus, the weight for an adult is $w_{adult} = \frac{\frac{1+(n_{adult}-1)*0.5}{n_{adult}}}{1+(n_{adult}-1)*0.5+n_{children}*0.3}$ and for a child is $w_{child} = \frac{1}{(n_{adult}-1)*0.5+n_{children}*0.3}$, where n_{adult} is the number of adults and n_{adult} is the number of children in a given household. The recommended family expenditure shares are $Sh_{jh}^{CNPP} = \sum w_i Sh_{ijh}^{CNPP}$, where i represents a member of household h. Each household is assigned a recommended expenditure share of food group j based on the household structure. This measure penalizes households for purchasing food that is different from the guidelines, while it does not penalize them for purchasing more healthful food. It also values food diversity as the diet quality decreases if households only consume from a select group of healthful food products. Therefore, USDAScore emphasizes the food structure and provides a more complete picture of diet quality in comparison to raw expenditure share measures.

All of our measures of diet quality are based on expenditure shares from a select group of food categories. This has both advantages and disadvantages. First, as Nielsen HomeScan data record the exact purchased products and their prices, we have accurate calculations for expenditure shares for different food groups. Second, as the expenditure shares of food groups, such as fruits and vegetables, are widely used it is easy to compare our results with other studies. One of the major weaknesses, however, is that our measures may be affected by prices. For example, our measures would suggest that diet quality increases if the prices for fruits and vegetables increase and food purchases stay the same.

2.2.2 Independent Variables

Our main variable of interest is working hours and whether the female household head is not working for payment. We focuson female headssince they often decide what meals to buy and how much time to spend cooking. We also control for the following variables: family income, dummies indicating a household head's education level, female household head's age, a dummy indicating the household head's marital status, a dummy indicating the presence of children, and dummies for race, dummies indicating male heads working status. All of these variables come directly from the Nielsen HomeScan panel.

2.3 Summary Statistics

Table 1 lists the 23 food groups used in constructing our household-level diet variables. In this table, we show the expenditure share of average households in our sample and the recommended share for a representative household.[5] As is shown, the expenditure shares in the healthful food groups - dark vegetables, fruits, canned and dry beans, lentils, peas, and white meat - are consistently below the amounts recommended by USDA, while households consume significantly more than is recommended from the unhealthful categories - soft drinks, sodas, fruit drinks, sugars, sweets, candies, and frozen or refrigerated dinners. Overall, the total expenditure for healthful food is 34.3%, while the recommended share is 82%.

Table 2 presents summary statistics for the variables used in our econometric analysis. The sample we use in this study comprises 461,303 household-year observations. Panel A shows the descriptive statistics for our outcome variables and Panel B provides summary statistics for our variables of interest and control variables.

[5]The representative household consists of one male and one female aged 19-50, one child aged 9-11, and one child aged 6-8

3 The Impact of Working Hours on Diet Quality: Fixed Effect Model

In this section, we first describe our main model which is a panel data model with household and year fixed effects. Then, we will present the effects of female heads' working hours on diet quality based on our fixed effect model.

3.1 Econometric Model

To identify the impact of female labor force participation on dietary outcomes, we first estimate the following panel data regression with household and yearly fixed effects:

$$Y_{ht} = \beta_0 + \beta_1 work_{ht} + X_{ht}\delta + \lambda_h + \mu_t + \epsilon_{ht}, \tag{1}$$

where Y_{ht} represents our outcome variable for household h, in year t; $work_{ht}$ is the working hours for the female heads in the family in year t; X_{ht} is a vector of control variables, μ_t represents yearly fixed effect, and λ_h is a set of household fixed effects. In this study, the outcome variable Y_{ht} is diet quality. As we mentioned before, we have three different measures of the healthfulness of the food purchases: the expenditure share of fruits and vegetables, the expenditure share of all healthful food, and USDAScore. The vector of control variables includes: family income, household head education level, female household head's age, marital status indicator, number of children in the family, race, and male head working status. Our variable of interest is $work_{ht}$. In the data, female heads have four different types of employment status: not working for payment, working 0-30 hours per week, working 30-35 hours per week, and working 35 hours or above per week. Based on this information, we use two ways to measure female heads' labor force participation. One is that we use a dummy variable indicating whether the female head is working for payment or not. Second is that we convert the four different working statuses into working hours.[6]

[6] We convert the categorical variable to a continuous variable by calculating the mean value of working hours.

To ensure that our results are not driven by households migrating between zip codes, we consider the same household living in different zip codes in different periods as separate observations. Therefore, we track diet changes for the same household in the same zip code using household fixed effects λ_h. In this way, we are able to avoid selection bias as households who value health may move to more expensive communities with a better food environment. Finally, we control for year fixed effects μ_t to capture time-varying macro shocks. The coefficient β_1 is our estimator of interest.

3.2 Results from the Fixed Effect Model

Using yearly data from 2004-2013, we estimate the effects of female labor force participation on diet quality using the fixed effect model based on Equation 1. Table 3 shows the results from the FE model. Columns(1)-(3) show the impact of the female head working hours on the expenditure of the expenditure share of fruits and vegetables, the expenditure share of all healthful food, and USDAScore, while columns (4)-(6) show the effect of female head not working for payment. The results are consistent that working hours have negative effects on diet quality and not working would increase the diet quality. Specifically, we see a 0.4%-0.5% decrease in diet quality with the female head's working hours increasing by 10 hours and if the female head is not working for the payment, the diet quality increases by about 0.9%-1.5%. Based on the fixed effect model results, we find that diet quality decrease as female heads work more hours.

4 Fixed Effect Instrument Variable Method

4.1 FE-IV Model

The estimate of the key coefficient β_1 from Equations (1) is unbiased if the female head's working hours are exogenous. The decision on the labor supply usually is endogenous with many considerations. The FE model helps to correct the biased estimates caused by time-invariant omitted variables. But the FE model and household characteristics controls do not address the potential endogeneity coming from the reverse causality or time-variant omitted variable bias. In our model, the endogeneity is caused by a variety of reasons. First, the decision on diet quality and female labor force participation can occur simultaneously. Families with a strong preference for diet quality would allocate more time to prepare healthful food and reduce female working hours. This would result in a overestimate of the impact of working hours on diet quality. However, we already use the FE model and it can mitigate the impact on our estimates from omitted preference, with the assumption that preference is steady over time. Second, omitted variables related to wealth and income are directly related to working hours and diet quality. For example, a sudden wealth increase may reduce the working hours and also increase the diet quality, resulting in an upward bias in the estimation. Third, omitted variables related to the family's health situation can also be related to both the working hours of the female head and diet quality. The female's working hours would decrease and may pay more attention to diet quality if one of the family member experience some health issue. The coefficient β_1 would be underestimated in this case. Therefore, the omitted variables issue would bias the estimate in both directions.

To address the endogeneity associated with the female head working hours, we extend our main specifications Equations (1) and estimate an instrumental variable (IV) model. Following Hinnosaar (2018), Fitzpatrick & Moore (2018), and Smed *et al.* (2022), we use Social Security Retirement Insurance eligibility as the instrumental variable. Americans are eligible for partial Social Security benefits at age 62 and full benefits at age 65 (Fitzpatrick & Moore, 2018; Hinnosaar, 2018). Around 31% Americans claim the benefits in their first month of eligibility and reduce their work hours (Fitzpatrick & Moore, 2018). Based on this, we create a Social Security eligible indicator. The value of the indicator is 1 if the age is 65 or above, the value is 0.5 if the age is between 62 and 65, and the value is 0 if the age is below 62.

We estimate our IV model using two-stage least squares (2SLS). The first stage of our IV model is specified as follows:

$$work_{ht} = \alpha_0 + \alpha_1 eligible\_ind_{ht} + X_{ht}\sigma + \lambda_h + \mu_t + e_{ht}, \tag{2}$$

where $eligible\_ind_{ht}$ represents the Social Security eligible indicator (the value is 1 if the age is 65 or above, the value is 0.5 if the age is between 62 and 65, and the value is 0 if the age is below 62).

$$y_{ht} = \beta_0 + \beta_1 \widehat{work_{ht}} + X_{ht}\delta + \lambda_h + \mu_t + \epsilon_{ht}, \tag{3}$$

where $\widehat{work_{ht}}$ is the predicted value for $work_{ht}$ from the first stage regression.

4.2 Results from the FE-IV Model

As we have discussed before, the impact of the female head working hours on diet quality from Table 3 is likely to be biased as the working decision is an endogenous choice. To address this, we extend our main FE model to the FE-IV model. We use Social Security eligible indicator as the instrumental variable for the female working hours.

As the instrumental variable we use is the eligibility for Social Security benefits, the major impact group is households with aged 60s. The younger group may have a different lifestyle from the older households who are close to retirement. In order to mitigate the effect coming from large age gaps, we focus on households with female heads aged 55-74 in the FE-IV model following Hinnosaar (2018) and Smed *et al.* (2022).

Table 4 shows the first stage results from the FE-IV model. The eligibility indicator of Social Security benefits have significant effect on female head's labor force participation. The sign of the coefficient is expected that the eligibility of social security benefits reduce the female head's workings and increase the likelihood of not working for payment. We also find that our weak instrument tests - F-tests - are at or above the results specified in Stock & Yogo (2002). Using these results, we proceed with the estimation of our IV models.

Table 5 shows the second stage results from the FE-IV model. As we can see, Panels A, B, and C show the effect of female head labor force participation on the expenditure of the expenditure share of fruits and vegetables, the expenditure share of all healthful food, and USDAScore. Column (1) shows the effect of the female head working hours on diet quality from the FE model for households with female heads aged 55-74, while column (2) shows the results for the FE-IV model. Columns (3) and (4) show similar results on the impact of whether the female heads work for payment or not. By comparing the full sample FE results from Table 3 with the sample with age 55-74, the effects are very similar and the magnitudes of the effects are slightly higher in the female head aged 55-75 sample than those in the full sample. If we look at the results from FE and FE-IV models in Table 5, we can find that the results from FE and FE-IV models are consistent in terms of coefficient sign and significance levels and they are not considerably divergent in terms of their magnitude as well. Based on the FE-IV model results, we find that the diet quality can improve by 2.3%-4.5% with a 10 hours decrease in female head working hours and the diet quality increases by 11.2%-18.7% if the female head does not work for payment.

To summarize the results presented in Tables 3-5, we find that female head labor force participation has a negative impact on diet quality. These results hold across all of our non-IV and IV models.

5 How Do Working Hours Affect Grocery Shopping Behaviors?

We find significant effects of female head labor force participation on diet quality in both FE and FE-IV models. One reason we demonstrate this case is that working female heads have less time allocated to food preparation and that will allow us to observe additional evidence on the impact of time constraints on diet quality. In this section, we show how working hours affect shopping and food preparation.

5.1 The Effect on Shopping Frequency

One direct effect of working hours on shopping behaviors is that households would reduce the frequency of grocery shopping under the time constraint. Rudi *et al.* (2017) show that grocery shopping frequency is important for diet quality. They find a one-unit increase in monthly shopping frequency decreases the share of expenditures on healthful foods by a range of 1.36-6.12 percentage points. In this part, we estimate the effect of female working hours on grocery shopping frequency.

We use two ways to measure the grocery shopping frequency. First, we use the total grocery trips. Second, we use the total days of grocery shopping. As we can see, Table 6 and 7 show the results of female working hours on the grocery shopping frequency. The results confirm our hypothesis that working hours would reduce the number of trips to grocery shopping and conversely, not working would increase the grocery shopping trips. For example, if the working hour increases by 10, the total grocery trips would decrease by 1.9% and the total days of grocery shopping decrease by 1.7% for the full sample in the IV model. Conversely, for the female heads not working, such results range between 5.3 % and 4.7%. These findings imply that time constraints forces households to make fewer trips to the grocery store and they make more trips when the time constraints are relaxed. Such results are consistent with regard to the FE-IV models as well. These findings imply that time constraints induce households to make poor dietary choices.

5.2 The Effect on Frozen and Prepared Food

We have shown that the family reduces the shopping frequency with more working hours of female heads. With fewer trips to the grocery stores, households would purchase fewer fresh vegetables and fruits and buy more frozen and prepared food. As we have shown that female heads' working hours have a negative effect on the expenditure share of vegetables and fruits in the previous session, here we examine whether the working hours of female heads have an impact on frozen and prepared food purchases. The dependent variable is the expenditure share on frozen and prepared food. Based on Table 1, the expenditure share of frozen and prepared food is about 9.6%, while the recommended share is only 0.18%. The US family spends too much on frozen and prepared food.

Table 8 shows the results for the impacts of female working hours on frozen and prepared food. The findings confirm our hypothesis that working more hours would induce households to consume more frozen and prepared food (consistent with findings associated with grocery shopping frequency). For instance, in the FE model, if the working hours increase by 10, the share of frozen food expenditure increases by 1.1% in the full sample and by 1.2% in the sub sample containing age groups between 55 and 74 years old. For the FE-IV mode, such an estimate is 4.5%. Conversely, the frozen food consumption decreases by 2.7% in the full sample FE model, by 2.8% in the sub-samples of ages 55-74 and by 18.4% in the FE-IV model. Like before, slightly higher coefficients for FE-IV models confirm our hypothesis that working hours are endogenous decisions.

6 Conclusions

In this paper, we examine how female labor force participation impacts household food consumption. We are specifically interested in how the female head's working hours are related to diet quality. To answer these questions, we use a nationally representative consumer expenditure panel data set from Nielsen (HomeScan). To deal with endogeneity issues associated with labor force participation, we use the FE-IV method and the instrument variable is the eligibility for Social Security benefits.

The results from our models show that the working hours of female heads have a negative impact on diet quality. We find a 1%-1.3% decrease in the diet quality with a 10 hours increase in female find's working hours in the FE model, while the decrease in diet quality is 2.3%-4.5% for the same working hours change in the FE-IV model. We also find supporting evidence showing that the impact of female labor force participation on diet quality can be through time constraints. We find that the family with female heads working more hours significantly reduce their trips to grocery shopping and switch their purchase from fruits and vegetables to frozen and prepared food.

While our study provides some very important insights, it also has some limitations. First, the Nielsen HomeScan panel data set does not include food away from home. Although Alcott *et al.* (2017) find that grocery purchases are not a systematically biased measure of overall diet healthfulness, it is still necessary to reexamine the effects using data including both food at home and away from home. Second, our measures of diet quality may be measured with error. All three of our diet quality measures are based on expenditure shares. While expenditure-based measures have their advantages, because they are expenditures they have the tendency to be impacted by price changes. Thus, it will be important to include other measures, such as nutrition, in future work. Third, both the FE and the FE-IV models focus on a short horizon. Usually, habit is very sticky, and it is hard to change it in the short run. Therefore, it is crucial to check whether the time constraint has a long run effect on diet quality in the future.

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Table 1: USDA Food Categorization

Healthful	Share(%)	Recommended share(%)	Unhealthful	Share(%)	Recommended share(%)
Whole grain products	10.49	10.09	Non-whole grain products	11.69	6.10
Potato products	2.06	1.77	Whole milk products	1.47	0.86
Dark green vegetables	0.46	5.59	Cheese	5.33	0.60
Orange vegetables	0.57	2.61	Beef, pork, veal, lamb, and game	6.48	5.31
Canned and fry beans, lentils, and peas	0.37	8.32	Bacon, sausage, and luncheon meats	1.34	0.91
Other vegetables	2.85	8.66	Fats and condiments	2.47	1.79
Whole fruits	4.01	16.49	Soft drinks, sodas, fruit drinks, and ades	8.43	1.33
Fruit juices	2.31	1.86	Sugars,sweets, and candies	15.38	0.41
Reduced fat, skim milk, and low-fat yogurt	5.40	8.77	Soups	3.50	0.51
Chicken, turkey, and game birds	0.09	2.69	Frozen or refrigerated entrees	9.6	0.18
Fish and fish products	1.73	11.92	Total	65.70	18.00
Nuts, nut butters, and seeds	2.60	3.16			
Eggs and egg mixtures	1.38	0.12			
Total	34.3	82.00			

Note: The share of each food category is the real expenditure share for the average household in the Nielsen sample over our observation period. The recommended expenditure share is from a representative family according to the liberal food plan specified by USDA (Volpe & Okrent, 2013). The representative family includes one male and one female, age 19-50, one child age 9-11, and one child age 6-8.

Table 2: Summary Statistics

Variable	Obs	Mean	St. Dev.	Min	Max
Panel A: Outcome Variables					
Share of fruits and vegetables	461,303	0.10	0.06	0.00	0.91
Share of healthful food	461,303	0.34	0.11	0.01	0.97
USDAScore	461,303	9.90	4.19	1.05	30.00
Panel B: Independent Variables					
Female head employment					
Under 35 hours per week	461,303	0.13	0.33	0	1
30-34 hours per week	461,303	0.05	0.22	0	1
Above 35 hours per week	461,303	0.40	0.49	0	1
Not Employed for Pay	461,303	0.43	0.49	0	1
Hours (10)	461,303	1.94	1.84	0	4
Male head employment					
Under 35 hours per week	461,303	0.04	0.19	0	1
30-34 hours per week	461,303	0.02	0.14	0	1
Above 35 hours per week	461,303	0.44	0.50	0	1
Not Employed for Pay	461,303	0.23	0.42	0	1
Family income ($1k)	461,303	59.51	3.40	6.5	200
Household size	461,303	2.51	1.28	1	9
Female head education					
Some high school	461,303	0.03	0.17	0	1
High school	461,303	0.26	0.44	0	1
Some college	461,303	0.31	0.46	0	1
College	461,303	0.29	0.45	0	1
Post college	461,303	0.11	0.31	0	1
Female head age	461,303	53.93	12.14	22	70
Marital	461,303	0.70	0.46	0	1
No children in the family	461,303	0.75	0.43	0	1
White	461,303	0.82	0.39	0	1
Black	461,303	0.09	0.28	0	1

Table 3: Results for the Fixed Effect Model

	Ln(Expenditure share of fruits and vegetables) (1)	Ln(Expenditure Share of healthful food) (2)	Ln(USDAScore) (3)	Ln(Expenditure share of fruits and vegetables) (4)	Ln(Expenditure Share of healthful food) (5)	Ln(USDAScore) (6)
Female head working hours (10 hours)	-0.005***	-0.004***	-0.005***			
	(0.001)	(0.000)	(0.000)			
Female head not working				0.009***	0.015***	0.013***
				(0.001)	(0.002)	(0.001)
Household controls	Y	Y	Y	Y	Y	Y
Household fixed effects	Y	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y	Y	Y
Observations	422,342	422,342	422,342	422,342	422,342	422,342
R-squared	0.016	0.008	0.030	0.008	0.016	0.030

Note: This table presents the effect of female head labor force participation on diet quality based on fixed effect models. Outcome variables are shown across the top. Household controls include family income, household size, a dummy for the education level of the household head, male household head's age, female household head's age, a indicator for marital status, a indicator for the presence of children, and race dummies, dummies for male head employment status. Robust standard errors are in parentheses. * Significant at 10% level. ** Significant at 5% level. ***Significant at 1% level.

Table 4: First-Stage Results from FE-IV

	Female head working hours (10 hours)	Female head not working
	(1)	(2)
eligitiblity of sociel security benefits indicator	-0.385***	0.0926***
	(0.015)	(0.004)
Household controls	Y	Y
Household fixed effects	Y	Y
Year fixed effects	Y	Y
F Statistic	654.88	423.09
Observations	176,014	176,014
R_Squaree	0.11	0.09

Note: This table presents results from our first-stage IV model. Robust standard errors are in parentheses. * Significant at 10% level. ** Significant at 5% level. ***Significant at 1% level.

Table 5: Results for the Fixed Effect Instrumental Variable Model With Female Heads Aged 55-74

	Ln(Expenditure share of fruites and vegetabls food)	Ln(Expenditure share of healthful food)	Ln(Expenditure share of healthful food)	Ln(Expenditure share of healthful food)
	FE	FE-IV	FE	FE-IV
	(1)	(2)	(3)	(4)
	Panel A			
Female head working hours (10 hours)	-0.007***	-0.027**		
	(0.001)	(0.014)		
Female head not working			0.023***	0.112**
			(0.004)	(0.057)
Observations	176,014	176,014	176,014	176,014
	Ln(Expenditure share of healthful food)	Ln(Expenditure share of healthful food)	Ln(Expenditure share of healthful food)	Ln(Expenditure share of healthful food)
	FE	FE-IV	FE	FE-IV
	(1)	(2)	(3)	(4)
	Panel B			
Female head working hours (10 hours)	-0.005***	-0.023***		
	(0.001)	(0.007)		
Female head not working			0.013***	0.098***
			(0.002)	(0.029)
Observations	176,014	176,014	176,014	176,014
	Ln(USDAScore)	Ln(USDAScore)	Ln(USDAScore)	Ln(USDAScore)
	FE	FE-IV	FE	FE-IV
	(1)	(2)	(3)	(4)
	Panel C			
Female head working hours (10 hours)	-0.007***	-0.045***		
	(0.001)	(0.008)		
Female head not working			0.020***	0.187***
			(0.002)	(0.036)
Observations	176,014	176,014	176,014	176,014

Note: This table presents the estimates of female labor force participation on diet quality for both FE and FE-IV models under the sample with female head aged 55-74. The control variables are the same as (3). Robust standard errors are in parentheses. * Significant at 10% level. ** Significant at 5% level. ***Significant at 1% level.

Table 6: Results for Labor Force Participation of Female Head on the Count of Grocery Trips

	Ln(Count of grocery trips)	Ln(Count of of grocery trips)	Ln(Count of of grocery trips)	Ln(Count of grocery trips)	Ln(Count of grocery trips)	Ln(Count of grocery trips)
	FE Full sample (1)	FE age55-74 (2)	FE-IV age55-74 (3)	FE Full sample (4)	FE age55-74 (5)	FE-IV age55-74 (6)
Female head working hours (10 hours)	-0.019*** (0.001)	-0.016*** (0.001)	-0.066*** (0.010)			
Female head not working				0.053*** (0.002)	0.039*** (0.003)	0.276*** (0.042)
Observations	422,342	176,014	176,014	422,342	176,014	176,014

Note: This table presents the estimates of female labor force participation on total trips of grocery shopping for both FE and FE-IV models under the full sample and the sample with female head aged 55-74. The control variables are the same as (5) Robust standard errors are in parentheses. * Significant at 10% level. ** Significant at 5% level. ***Significant at 1% level.

Table 7: Results for Female Labor Force Participation on the Number of Days for Grocery Shopping

	Ln(Number of days for grocery shopping)	Ln(Number of days for grocery shopping)	Ln(Number of days for grocery shopping)	Ln(Number of days for grocery shopping)	Ln(Number of days for grocery shopping)	Ln(Number of days for grocery shopping)
	FE Full sample (1)	FE age55-74 (2)	FE-IV age55-74 (3)	FE Full sample (4)	FE age55-74 (5)	FE-IV age55-74 (6)
Female head working hours (10 hours)	-0.017***	-0.013***	-0.052***			
	(0.001)	(0.001)	(0.009)			
Female head not working				0.047***	0.031***	0.214***
				(0.002)	(0.002)	(0.039)
Observations	422,342	176,014	176,014	422,342	176,014	176,014

Note: This table presents the estimates of female labor force participation on the number of days of grocery shopping for both FE and FE-IV models under the full sample and the sample with female head aged 55-74. The control variables are the same as (5) Robust standard errors are in parentheses. * Significant at 10% level. ** Significant at 5% level. ***Significant at 1% level.

Table 8: Results for Labor Force Participation of Female Head on the Frozen Food

	Ln(Expenditure share of frozen food)	Ln(Expenditure share of frozen food)	Ln(Expenditure share of frozen food)	Ln(Expenditure share of frozen food)	Ln(Expenditure share of frozen food)	Ln(Expenditure share of frozen food)
	FE	FEIV	FE	FE	FEIV	
	Full sample	age55-74	age55-74	Full sample	age55-74	age55-74
	(1)	(2)	(3)	(4)	(5)	(6)
Female head working hours (10 hours)	0.012***	0.013***	0.041**			
	(0.001)	(0.001)	(0.018)			
Female head not working				-0.031***	-0.028***	-0.167**
				(0.003)	(0.005)	(0.074)
Observations	422,342	176,014	176,014	422,342	176,014	176,014

Note: This table presents the estimates of female labor force participation on the expenditure share of frozen food for both FE and FE-IV models under the full sample and the sample with female head aged 55-74. The control variables are the same as (5) Robust standard errors are in parentheses. * Significant at 10% level. ** Significant at 5% level. ***Significant at 1% level.