Are fruit and vegetables good for our mental and physical health? Panel data evidence from Australia

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Abstract

This paper studies the effect of fruit and vegetable consumption on human well-being. Using individual-level panel data from a representative sample of Australian households, I estimate the intake of fruit and vegetables to have positive and statistically significant impacts on a wide range of subjective well-being measures, including life satisfaction, self-assessed health, mental health, psychological distress, and vitality. The estimated relationships are mainly non-monotonic in nature. For most well-being measures, the optimal consumption bundle consists of 4-5 daily portions of fruit and 4-5 daily portions of vegetables. The intake of fruit is predicted to have a greater relative impact (than vegetables) on overall mental health and psychological distress scores. There are also gender differences in the estimated effects, with the intake of fruit and vegetables increasing average happiness and self-reported health scores of women significantly more than that of men. Overall, the results imply that less than one-quarter of adults in Australia consume the optimal daily amount and mix of fruit and vegetables. I discuss the relevance of the findings for government policy-makers and health professionals, in reference to existing public health promotions and guidelines.

JEL Classification: D12, I12, I18, I31, C33.

Keywords: subjective well-being, fruit and vegetables, diet, life satisfaction, mental health, public health policy, panel data, fixed effects.

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1. Introduction

The study of human happiness and mental well-being has been one of the most popular research tasks undertaken by social scientists and health scholars in recent times (see, e.g., Diener et al. 1994; Easterlin 2003; Blanchflower and Oswald 2004; Frijters et al. 2004; Layard 2005; Shields and Wheatley Price 2005; Powdthavee and Van den Berg 2011; Boyce and Oswald 2012; Johnston et al. 2013). While existing work has established a robust set of demographic and socioeconomic factors that are strongly associated with people's well-being, so far only a handful of studies have focused on the role that dietary choices, or different types of foods, play in explaining the emotional states of individuals.[1] The latter empirical relationship has also been largely ignored in policy circles, with the World Health Organization (1990), for example, mainly focusing on the physical health of individuals when recommending a consumption amount of five portions of fruit and vegetables per day.[2]

Such healthy eating guidelines have since been promoted by a number of governments around the world, including in the UK and other parts of Europe (such as Germany, Netherlands, and Norway) as well as New Zealand, while public health departments in Australia, Canada, Denmark, France, Japan, and the United States have moved toward slightly more expansive dietary messages. For example, in 2007, state health institutions in the USA gave preference to the 'Fruit and Veggies- More Matters' campaign.

[1] Most empirical studies find factors such as employment status, personal health, marriage, and religion to positively influence people's well-being; while being unemployed, divorced, and unhealthy leads to lower reported levels of subjective well-being. See, for example, Clark et al. (2008) and Dolan et al. (2008) for recent surveys of the empirical happiness literature. Based on such evidence, a number of academics have also proposed for public policy to be more oriented towards raising the overall happiness of society, instead of upholding the traditional goal of economic growth (see, e.g., Dolan and White 2007; Diener 2009; Oswald 2010).

[2] The '5 a day- for better health!' public health policy recommendation originated at the California Department of Health Services during the late 1980s; linking higher fruit-and-vegetable consumption to lower rates of cardiovascular disease and some cancers (Foerster et al. 1995). More recent work by Oyebode et al. (2014) finds a strong negative correlation between fruit and vegetable consumption and mortality in a nationally-representative sample of 65,226 individuals from England. The authors estimate that eating 7 or more daily portions of fruit and vegetables reduces the probability of death at any point of time by 42% more than when eating less than one daily portion. Moreover, the intake of vegetables is reported to have a relatively stronger association with lower morality than the intake of fruit.

And, a few years earlier in 2005, the Australian government initiated the 'Go for 2+5' promotion; suggesting an optimal intake amount of two portions of fruit and five portions of vegetables a day. Similarly, 'The Mix it up! 5-to-10-a-day' campaign has been promoted on a large-scale across Canada.[3] The estimated costs of such promotional campaigns have reached multiple millions of dollars (Rekhy and McConchie 2014); with, for example, the 'Food Dudes' program in the UK costing around 16.58 million (USD) since being initiated in 1992. Similarly, the USA government has directed around 3-5 million (USD) of public funds towards the 'Fruit and Veggies- More Matters' program each year since 2007, while in Australia approximately 4.76 million (USD) has been expended on the 'Go for 2+5' campaign during the period between 2005 and 2007. Nonetheless, a key issue surrounding the above public health announcements and social marketing programs has been the clear lack of an empirical basis, especially about any potential effects that the consumption of fruit and vegetables may have on people's psychological well-being.

Important recent exceptions and contributions to the well-being literature are studies by Blanchflower et al. (2013) and White et al. (2013), which examine the empirical link between subjective well-being and the intake of fruit and vegetables.[4] Blanchflower et al. (2013) use cross-sectional data on approximately 80,000 random individuals from different parts of Great Britain. The authors report a positive correlation between the consumption of

[3] For more details about the different fruit-and-vegetable healthy eating guidelines and campaigns in place around the world, see the following online establishments (by country): Australia (www.gofor2and5.com.au); Canada (www.5to10aday.com); Denmark (6omdagen.dk); France (www.mangerbouger.fr); Germany (www.5amtag.de); Netherlands (www.groentenenfruit.nl); New Zealand (www.5aday.co.nz), Norway (www.frukt.no); United Kingdom (www.nhs.uk/Livewell/5ADAY/Pages/5ADAYhome.aspx); and the United States (www.fruitsandveggiesmorematters.org). See also Rekhy and McConchie (2014) for a detailed evaluation of selected national programs.

[4] For a survey of other related studies within the science and social science literatures, see Rooney et al. (2013). Blanchflower et al. (2013) present a complete list of available academic papers and reports which are empirically based around the topic of fruit-and-vegetable consumption. Also, see White et al. (2013), and the references therein, for a review of existing laboratory and cross-sectional evidence on the relationship between negative emotional states and eating behaviour. For example, Boehm et al. (2013) examine cross-sectional data on 932 men and women from the Midlife in the United States study to find that individuals who consumed two or less portions of fruit and vegetables a day were significantly less optimistic than those who consumed three or more portions.

fruit and vegetables and seven different well-being measures, including life satisfaction and self-assessed health. Based on standard regression estimates, the optimal consumption amount is identified to be around 7 portions of fruit and vegetables a day. However, as outlined by the authors, a potential econometric issue in this line of work concerns the notion of reverse causality: that is, one's level of happiness may well be determined by the amount of fruit and vegetables that the person consumes, but it could also be true that happier people simply eat more of these foods. At the same time, a number of unobserved confounding factors, such as family health background and personal levels of motivation, may lead to biased inferences about the empirical relationship of interest. This endogeneity problem can be partially overcome with the use of panel data, whereby multiple observations on a single survey respondent allow the researcher to control for unobserved individual traits which are fixed over time. To this end, White et al. (2013) study daily diary data on the food intake behaviour and self-reported well-being levels of 281 undergraduate students from the University of Otago (New Zealand) for 21 consecutive days. Accounting for the longitudinal nature of the collected information, the authors find that eating more fruit and vegetables (up to 8 portions a day) is likely to increase emotional well-being, especially among healthy young adults.[5]

The present paper adds to the above limited number of studies by using individual-level panel data from a representative sample of Australian households to estimate the effects of fruit and vegetable consumption on a variety of mental and physical health measures. The analysed sample from the HILDA Survey consists of more than 12,000 individuals that are followed over two waves in years 2007 and 2009. The survey also contains separate questions relating to the daily intake of fruit and vegetables by each respondent, allowing for

[5] For a description of the different possible mechanisms via which fruit and vegetable consumption may influence the emotional states of individuals, such as through the absorption of water-soluble minerals and vitamins (potassium and folic acid) - which in turn have an effect on adrenaline and serotonin receptors; see, for example, Gilbody et al. (2007) and Torres et al. (2008) and the references therein.

more detailed inference on the empirical relationship at hand. Such independent fruit and vegetable consumption effects are not examined in most previous studies which, due to different questionnaire formats, bundle the two foods together. To test the robustness of any possible link between the consumption of fruit and vegetables and human well-being, I estimate a series of fixed effects regression equations using a variety of respondent-evaluated psychological and physical health scores, or outcome measures. This set also includes more objective mental health indicators than available in most household survey data, namely a formal diagnosis of depression/anxiety by the respondent's doctor.

More specifically, I consider three main questions of empirical nature:

(1) Is there an empirical relationship between the consumption of fruit and vegetables and self-reported measures of mental and physical well-being?

(2) Does the intake of fruit and vegetables have separate/independent effects on people's well-being, and are these effects more profound in some health outcomes than others?

(3) What is the optimal fruit and vegetable consumption bundle (amount and mix), and does this basket vary across the different measures of well-being?

After controlling for a number of potential confounding factors (such as education, income, and health consciousness) as well as unobserved individual heterogeneity (and selection effects), I find evidence of a significant positive relationship between the consumption of fruit and vegetables and higher levels of subjective well-being. The estimated effects are however not as monotonic and large as those found in recent cross-sectional studies. For many of the well-being measures, the optimal consumption bundle is estimated to be at '4 to 5' portions of fruit and '4 to 5' portions of vegetables a day. These combined consumption amounts are thus higher than the 5-a-day policy promoted by many governments and public health organisations around the world. The found results are nevertheless closely in line with recent empirical evidence from the UK (Blanchflower et al.

2013; Oyebode et al. 2014) and New Zealand (White et al. 2013), suggesting the need for upward revisions to existing healthy-eating targets.

Moreover, I find fruit and vegetables to have separate and varying effects across the different measures of well-being. That is, while fruit and vegetables are each found to similarly impact average happiness and self-assessed health scores, the daily intake of fruit is shown to be solely associated with improved mental health and psychological distress levels. On the other hand, eating higher amounts of vegetables is predicted to have a greater relative impact on selected general health measures, in particular those items reflecting individual health comparisons to that of familiar others. There is also some evidence of gender differences in the estimated fruit and vegetable effects, with the intake of fruit and vegetables boosting individual happiness and general health scores of women significantly more than that of men.

The rest of the paper is structured as follows: Section 2 describes the HILDA Survey data and well-being measures of interest. Section 3 outlines the empirical methodology. Section 4 presents the estimation results. Section 5 concludes with some policy implications and future directions.

2. Data, Variable Definitions and Summary Statistics

The data in this study come from Waves 7 and 9 (years 2007 and 2009) of the Household, Income and Labour Dynamics in Australia (HILDA) Survey, a nationally representative panel survey that was first conducted in 2001. The HILDA Survey collects detailed longitudinal information from members of Australian households who are at least 15 years of age; with a total of 13,969 individuals from 7,682 different households interviewed in the first wave. Data is collected annually via both face-to-face interviews and self-completion questionnaires. The former technique is mainly used to gather demographic and

socioeconomic information, while the latter is used to capture the health levels and lifestyle choices of respondents. For more detailed information about the survey, see Watson and Wooden (2002). After excluding respondents with missing information on the key outcome and control variables, the total sample analysed in this study consists of around 12,389 individuals (aged 15 to 93) and 20,136 person-year observations. As expected, however, these sample figures vary slightly across the different well-being measures examined.

2.1 Fruit and Vegetable Consumption

Two separate questions relating to the frequency and amount of fruit and vegetable consumption are available in Waves 7 and 9 only. The corresponding person questionnaires are as follows:

> *- Including tinned, frozen, dried and fresh fruit, on how many days in a usual week do you eat fruit?*
>
> *- Including tinned, frozen and fresh vegetables, on how many days in a usual week do you eat vegetables?*

with possible responses ranging from 0 ('do not eat any fruit or vegetables in a usual week') to 7 days per week. For individuals that respond with some positive frequency to the questions above, the following is also asked of them:

> *- On a day when you eat fruit, how many serves of fruit do you usually eat?*
> *- On a day when you eat vegetables, how many serves of vegetables do you usually eat?*

After hearing these questions, the survey respondents are then shown flashcards to visually define a serving size or portion (see Figures A1 and A2), with possible answers ranging from '1' to '6 or more' portions.[6]

[6] The questions related to fruit and vegetable consumption were originally adopted from the ABS 2004/05 National Health Survey (see HILDA Survey Annual Report 2008, and HILDA User Manual – Release 12).

I multiply the responses to these paired (frequency and quantity) questions to form a weekly consumption amount of fruit and vegetables, respectively. I then divide each product by seven to arrive at the average daily amount consumed by each person. I also retain all of the survey respondents who indicated in the frequency question above that they did not consume any fruit or vegetables in a typical week. The latter group of individuals forms the 'none' or 'zero' consumption category. Tables A1 and A2 present distributions of the average daily intake of fruit and vegetables for the sampled individuals, with around 85% of respondents having less than 3 daily servings of fruit, and more than 60% consuming less than 3 daily servings of vegetables. A very small fraction of the surveyed individuals consume, on average, more than 5 servings of fruit (1.83%) or vegetables (7.75%) each day.

2.2 Self-Reported Mental and Physical Well-being

To evaluate the impact of fruit and vegetable consumption on individual well-being, I consider a range of self-reported mental and physical health measures. These outcome variables are summarised and further defined in Table 1.

2.2.1 Life Satisfaction

The first dependent variable examined is self-reported life satisfaction or happiness, derived from the question: "*All things considered, how satisfied are you with your life?*" Respondents are told to: "*Pick a number between 0 and 10 to indicate how satisfied you are*", and that "*the more satisfied you are the higher number you should pick*". The responses to this HILDA Survey question have been used to analyse individual well-being effects in number of recent applications, including informal caregiving (Van den Berg et al. 2014), workplace promotions (Johnston and Lee 2012), and major life events (Frijters et al. 2011). Overall, the mean score for the sampled individuals in Australia is 7.91 with a standard deviation of 1.41. About two-thirds of respondents report a happiness score of more than 7 out of 10.

2.2.2 Self-Assessed Health

Another available measure of general well-being is self-assessed health (SAH). Individuals are asked the question: "*In general, would you say your health is: Excellent, Very Good, Good, Fair, or Poor*". The resulting response distribution is as follows: 3% (Poor); 12.8% (Fair); 35.2% (Good); 36.8% (Very Good); 12.1% (Excellent). In the analysis below, these individual responses are coded from 1 (Poor) to 5 (Excellent), with the average reported score being 3.42 out of 5.

The above SAH measure is the main generic health variable available in the Medical Outcomes Short Form (SF-36) Questionnaire; which forms a part of the annual HILDA Survey. The SF-36 is a one of the most widely used and validated self-completion measures of health status available (Ware 2000; Butterworth and Crosier 2004), consisting of 36 items/questions; 35 of which are used to derive eight health subscales/indices. These can be divided into two broad 'mental' and 'physical' health categories. The mental health subgroup consist of the Mental Health; Role Emotional; Vitality; and Social Functioning indices, while the physical health subgroup includes the General Health; Physical Functioning; Role Physical; and Bodily Pain scales. Within each health module, the respondent is asked how much of the time in the past four weeks did he/she experience particular types of feelings/symptoms, such as 'been a happy person', 'felt full of life', 'felt down', 'felt tired' etc. The raw survey responses are then transformed and standardised to a 100-point scale, with higher values indicating better levels of health and functioning.

Since individual respondents can think of various health-related domains and shocks when answering the SAH question above, personal experiences in many of the listed SF-36 domains could then be driving their actual SAH score. Recent work by Au and Johnston (2013) investigates the main components of the SF-36 that best explain respondent choices relating to self-assessed health. The authors identify the vitality domain as being the most

contributing measurement, while the other remaining domains do not seem to play any significant role. Au and Johnston conclude that such partial findings may explain why many applied studies have so far reported rather weak socioeconomic gradients in SAH scores. I keep the latter in mind, and estimate separate regressions for self-assessed health and several of the other SF-36 health domains (including vitality).

2.2.3 Other Health Domains and Outcomes

The other dependent variables listed in Table 1 are also derived from the SF-36 survey. To proxy the mental well-being of individuals, I directly use the available information and aggregated health scores/indices from the Mental Health, Role Emotional, and Vitality domains.[7]

The SF-36 Mental Health index is also strongly correlated with the commonly used Kessler Psychological Distress Scale (-0.80); where the latter is a weighted scale based on the list of 10 items under the 'psychological distress' category.[8] For each latter item, individual responses are assigned a value between 1 and 5, and then summed together. As a result, the overall Psychological Distress (K10) score ranges from 10 to 50; with higher values reflecting worsening levels of psychological distress (for more details, see Wooden 2009).

To complement the above mental well-being measures, I additionally examine another (arguably more objective) psychological outcome only available in Waves 7 and 9 of

[7] The Mental Health index consists of 5 items measuring anxiety and depression. The Role Emotional scale includes 3 items that measure the extent to which emotional problems adversely impact on work or other daily activities. The Vitality index comprises 4 items capturing individual levels of energy and tiredness. The General Health index consists of 5 items which reflect individual perceptions of personal health and future health expectations. The Physical Functioning scale is made up of 10 items capturing the extent to which individuals are able to perform everyday activities such as walking, climbing stairs, bathing, and playing sports. The Role Physical scale includes 4 items which assess the degree to which physical health limits work and other daily activities. The Bodily Pain scale comprises 2 items measuring the level at which individuals experience pain and whether it limits daily activities at home and outside home. For more details on the SF-36 instrument, see Ware (2000) and Butterworth and Crosier (2004).

[8] For other recent applications of the aggregated Mental Health score/index from the HILDA Survey, see Bechtel et al. (2012) in the context of economic inequality; Roy and Schurer (2013) in the context of mental health persistence; Cornaglia et al. (2014) in the context of criminal activity; and Frijters et al. (2014) in the context of unemployment.

the HILDA Survey. This variable is a binary indicator of whether the respondent had ever been diagnosed with anxiety or depression by a medical doctor or health care professional and required treatment for more than six months: *'Have you ever been told by a doctor or nurse that you have any of the long-term health conditions listed below? Please only include those conditions that have lasted or are likely to last for six months or more: Anxiety/Depression'.* From Table 1, we see that around 17% of survey respondents indicated to have been diagnosed with such a mental health condition.

As a placebo test, I employ the more distinct physical health and functioning SF-36 indices, namely Physical Functioning, Role Physical, and Bodily Pain, which are quite unlikely to be improved by a slightly higher intake of fruit and/or vegetables; but may in any case lead individuals to feel better emotionally and hence self-report higher scores in these physical health domains.

I also consider the respondent's body mass index (BMI) as a dependent variable, with physical weight being a possible pathway between healthy-eating behaviour and subjective well-being. Recent studies using large sample data from both Australia and abroad have nevertheless failed to find any clear association between fruit-and-vegetable intake and individual BMI levels (see, e.g., Field et al. 2003; Charlton et al. 2014). I examine whether such findings also hold true in the present data.

3. Empirical Methodology

To answer the research questions of interest, I estimate fixed effects regression models of the form:

$$SWB_{it} = \alpha' \boldsymbol{Fruit}_{it} + \beta' \boldsymbol{Vegetables}_{it} + \gamma' \boldsymbol{X}_{it} + \delta' \boldsymbol{Z}_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

where the dependent variable is the subjective well-being of individual i at time period t; $Fruit_{it}$ and $Vegetables_{it}$ are vectors containing the different amounts of fruit and vegetables

consumed in each period; the vector X_{it} captures the standard set of time-varying controls found in most well-being studies; Z_{it} is a vector of other time-varying dietary and lifestyle controls; μ_i is an individual-level fixed effect; and ε_{it} is an error term.

The main aim is to estimate the parameter vectors α and β. The panel nature of the data allows us to do so by controlling for all time-invariant unobserved individual characteristics; μ_i. By eliminating the latter term from equation (1) above, we partially overcome the problem of endogeneity (stemming from omitted variable bias) which presents itself in most cross-sectional studies; whereby the explanatory variables are correlated with unobserved individual heterogeneity (Cameron and Trivedi 2005).[9] This implies that the fixed effects (within) estimator simply compares the well-being of the same individual after he/she consumes a higher or lower amount of fruit and vegetables at each point in time (relative to his/her overall mean intake amount).

Since more educated, wealthy, and health conscious individuals are quite likely to consume higher amounts of fruit and vegetables than others, the vector X_{it} consists of various demographic and socioeconomic controls. These are based on the standard set of empirical covariates common in the well-being literature, including age, income, education level, employment status, marital status, number of children, and physical health conditions such as disability. The descriptive statistics corresponding to these covariates are presented in Table

[9] To clearly identify the causal effects of fruit and vegetable consumption on individual well-being, one possible estimation strategy is to use month-area average fruit and vegetable prices as instruments for the corresponding levels of consumption. Such prices (from regional wholesale markets) are regularly published by the Australia Bureau of Statistics for selected fruits and vegetables, such as Cavendish and Lady Finger bananas (see ABS 2013). However, as the HILDA Survey data at hand only covers two separate waves (years 2007 and 2009), the available periods of respondent interviews (by month) are September 2007 through to February 2008, and September 2009 to February 2010, respectively. Banana prices during these two survey waves did not vary to any notable extent across the major cities in Australia; the mean wholesale price (per kg) of Cavendish bananas in Brisbane (Queensland), Sydney (New South Wales), and Melbourne (Victoria) was $2.21, $2.10, and $2.25 respectively (with standard deviations of 0.94, 0.83, and 0.71). This is in contrast to periods following natural disaster events, such as tropical cyclones, which have had large negative impacts on supply as well as planting delays, leading to significant increases in price levels for a duration of approximately 10 months following the event (see Ko and Frijters 2014)- tropical cyclones Larry (March 2006) and Yasi (January 2011) were two of the most destructive cyclones that made landfall in North Queensland, Australia, resulting in banana prices to peak at around $15 per kg during these years. Such natural variation in prices (and consumption levels) would have been ideal for identification purposes; however the available data fails to capture such particular timing.

A3 of the Appendix.

At the same time, as individuals who regularly eat fruit and vegetables are usually also healthy in other parts of their lives (or may simply be consuming more fruit and vegetables to compensate for the lack of other important foods), I account for a number of other dietary and lifestyle factors. The vector Z_{it} captures individual-level variables such as the amount of alcohol intake, cigarette smoking, physical exercise, BMI, as well as the consumption of red meat; fish; low-fat milk; other fatty foods such as potato chips, and the routine of having a regular breakfast. These possible confounding factors are not discussed in much further detail as they can be also found in other recent studies analysing the same waves of the HILDA Survey (see, e.g., Ribar 2013; Cobb-Clark et al. 2014). A complete summary of the dietary and lifestyle controls is provided in Table A4.

For the life satisfaction and self-assessed health dependent variables, I estimate equation (1) using both ordinary least squares (OLS) and fixed effects (FE) methods. This is primarily done in order to compare the resulting fruit and vegetable gradients across the two estimators, whereby the difference between the OLS and FE estimates can be interpreted as evidence of selection (in terms of time invariant characteristics); i.e., the average unobserved fixed characteristics of people who are more likely to consume the given amounts of fruits and/or vegetables. For the remaining well-being measures, I only estimate linear FE models, with the full set of available demographic, dietary and lifestyle controls activated.[10]

It should also be noted that any time-invariant explanatory variables, such as gender, are not identified under the FE method. Nevertheless, I explore gender differences in the resulting fruit and vegetable effects by estimating separate FE equations for male and female survey respondents. Moreover, since most of the included controls enter the regression

[10] The detailed pooled OLS and linear FE regression results (which include the estimated coefficients for all included explanatory variables) are available upon request from the author. Also, when using BMI as the dependent (outcome) variable (see Table 4), I remove this variable from the right-hand side of the regression equation.

models as sets of dummy variables; one of the latter binary elements is always omitted as the reference or baseline category. This information is reported under each table of estimation results.[11]

4. Estimation Results

4.1 Life Satisfaction Scores

The regression results in Table 2 indicate the consumption of fruit and vegetables to have positive and statistically significant effects on life satisfaction scores in Australia. Based on the OLS estimates, average life satisfaction peaks at '5 or more' daily portions of fruit, with the estimated marginal effect in column (1) being equal to 0.295. That is, individuals who consume at least 5 portions of fruit per day tend to report happiness scores that are on average 0.295 units higher (on a 0 to 10 scale) than respondents who consume less than one portion of fruit per day. This finding is statistically significant at the 1% level. The coefficient estimate however slightly reduces in magnitude following the inclusion of extra demographic (column 2) and dietary/lifestyle (column 3) controls. Moreover, the monotonic relationship between life satisfaction and fruit intake disappears in the latter specification, indicating other dietary and lifestyle choices to be correlated with fruit eating behaviour. On the other hand, a more robust monotonic relation holds for the consumption of vegetables, with average life satisfaction also maximised at '5 or more' serves per day. These estimates are also statistically significant at the 1% level.

Moving from the pooled OLS to the linear FE model (columns 4 to 6), the estimated fruit and vegetable effects become smaller in magnitude, and are much weaker in terms of

[11] Following many other empirical studies in the well-being literature, I assume the self-reported scores to be cardinal (instead of ordinal) in nature; i.e., the well-being difference between a 1 and a 2 is taken to be the same as the difference between a 4 and a 5, and so on. Ferrer-i-Carbonell and Frijters (2004) argue that is it more important to account for individual fixed effects than the ordinal nature of the left-hand side variable. In any case, the estimated results are qualitatively robust to using ordinal methods such as the fixed effects ordered logit model, or BUC (Blow-up and Cluster) estimator, recently developed by Baetschmann et al. (2011). These results are also available upon request from the author.

statistical significance. This is especially true for the fruit gradient in life satisfaction, where a clear non-monotonic relationship is apparent (peaking at '5 or more' portions a day). On the other hand, for vegetable consumption alone; average life satisfaction is maximised at approximately 4-5 daily portions, with the estimated coefficients (in columns 4 to 6) being less than half the magnitude of those reported under OLS. Such differences in the OLS and FE estimates suggest individual unobserved characteristics to be positively correlated with both the intake of fruit-and-vegetables and feelings of happiness (a positive selection effect). To place these effect sizes in perspective: based on the full specification in column (6) of Table 2, the relative size of the fruit effect (0.201) is roughly equivalent to the estimated absolute coefficient attached to 'being unemployed' (-0.218), while the increased happiness experienced from consuming 4-5 serves of vegetables per day (0.153) also comes close to offsetting this well-documented negative unemployment effect.

Overall, the estimation results in Table 1 suggest the consumption of fruit and vegetables to matter for happiness levels in Australia, with the optimal consumption bundle being equal to 9 or more servings of fruit and vegetables a day. This result is broadly consistent with recent empirical evidence from the UK and New Zealand, where Blanchflower et al. (2013) and White et al. (2013) find individual happiness and emotional well-being scores to be maximised at around 7-8 daily serves of fruit and vegetables.

There is also some evidence of gender differences in the estimated results: women are associated with stronger fruit and vegetable effects in self-reported life satisfaction than men (see Table A3). The mean life satisfaction of males seems to peak at 2 to 3 portions of vegetables per day (coefficient estimate of 0.150, $p = 0.02$), while there is no significant fruit gradient evident for male respondents at all. On the other hand, the average happiness score reported by females reaches a maximum at 4-5 portions of fruit per day (coefficient estimate of 0.213, $p = 0.08$), and similarly at 4-5 consumed portions of vegetables per day (coefficient

estimate of 0.187, p = 0.04). Hence, men who eat around 3 daily servings of vegetables are found to be significantly happier than men who eat less than 1 serving a day. And, women consuming 4-5 portions of fruit as well as 4-5 portions vegetables (that is, between 8 and 10 combined serves a day) are predicted to be among the happiest gender subgroups.

4.2 Self-Assessed Health Scores

In regards to self-assessed health, the fixed effect estimates from Table 3 suggest the optimal level to be reached at 3-4 daily portions of fruit. Individuals who consume the latter amount report SAH scores that are on average 0.08 units higher than individuals who eat closer to zero serves of fruit per day. A similar finding holds for the consumption of vegetables, with estimated SAH reaching a peak at around 4-5 daily portions. For both the intake of fruit and vegetables, these estimated FE coefficients do not change significantly when additional demographic and dietary controls are included (columns 4 to 6). Relative to the OLS estimates (columns 1 to 3), the FE estimates are also generally smaller and less monotonic over the ordered consumption amounts, suggesting individual unobserved characteristics to be positively correlated with fruit and vegetable intake as well as self-assessed health scores. Overall, the combined bundle which maximises self-reported health is approximated to contain at least 7 daily serves of fruit and vegetables.

As with the estimated gender differences for the life satisfaction measure, the identified impacts of fruit and vegetable consumption on individual SAH scores are significantly higher for women than men (see Table A3). In this case, there is no resulting fruit or vegetable slope apparent for the male subsample, while significant fruit and vegetable consumption effects are estimated for the female subsample. The corresponding estimates are largest at 3-4 daily portions of fruit (0.121, p = 0.00) and 4-5 daily portions of vegetables (0.144, p = 0.00).

4.3 General Health Index

Tables 4, 5 and 6 report coefficient estimates from several other FE regressions, corresponding to the subset of well-being measures listed in Table 1. The results show that consuming 3 to 4 daily portions of fruit and 4 to 5 daily portions of vegetables maximises the General Health index (Table 4, column 1), holding all else constant. These point estimates are statistically significant at the 5% level. The sole intake of vegetables mainly influences respondent scores for the 'I feel as healthy as anybody I know' (Table 6, column 1), and 'I get sick a little easier than other people' (Table 6, column 2) measures; with statistically significant slopes estimated for the 3 to 5 daily portion range and 1 to 3 daily portion range, respectively. On the other hand, individuals who on average consume 4-5 serves of fruit a day report much more positive health expectations (Table 6, column 3) and yearly health improvements (Table 6, column 4), relative to individuals consuming the minimal amount. The latter effects are not apparent for the intake of vegetables, with each of the estimated parameters being statistically insignificant at conventional levels.

4.4 Other Mental Well-being Scores

4.4.1 Mental health

Tables 4 and 5 also show regression estimates for selected proxies of respondent mental health, as derived from the mental health module of the SF-36 instrument. From the estimation output, we observe the consumption of fruit to independently affect the Mental Health index (Table 4, column 2) as well as the other more specific (selected) items such as 'Been a happy person', 'Felt calm and peaceful', and 'Felt so down in the dumps that nothing could cheer you up' (see Table 5, columns 1 to 3). The first item can be viewed as a broad reflection of anxiety, while the latter two are common measures of depression. In any case, the above findings and estimated impacts are especially clear when respondents consume close to 4-5 servings of fruit per day.

Interestingly, the intake of vegetables does not seem to play any notable role in improving these same mental health measures. Overall, the consumption of fruit seems to predominantly contribute to the Mental Health index.

4.4.2 Psychological distress

I next consider the estimated effects of fruit and vegetable consumption on measures of psychological distress. On average, eating 4 to 5 portions of fruit per day is found to reduce the Kessler Psychological Distress (K10) Scale by around 0.493 units (relative to the baseline, or minimum, intake level). This result is however only significant at the 10% level (Table 4, column 3). On the other hand, consuming either lots or close to zero portions of vegetables a day makes no real difference to individual K10 scores. Looking at some of the specific psychological distress items (Table 5, columns 4 to 6): a zero gradient is also found for both fruit and vegetable intakes regarding self-reported feelings of 'depression', while there is a significant fruit effect evident when respondents evaluate their own levels of 'sadness' and 'unexplained tiredness'. For each of these distress measures, only the consumption of fruit is found to matter, with reported average scores optimised at around '5 or more' daily servings. Thus, similar to the mental health results above, only the intake of fruit (and not vegetables) is found to be of importance, after controlling for individual fixed effects and the complete set of socioeconomic and dietary/lifestyle characteristics.

The estimation results for the SF-36 'Felt depressed' item (Table 5, column 6) are also closely in line with the FE estimates for the more objective depression indicator (diagnosis) included in the last column of Table 6; where fairly small and statistically weak marginal effects are found.

The estimated impacts of fruit and vegetable consumption on the Role Emotional scale, a measure of the extent to which emotional problems (feeling depressed or anxious) adversely impact on work or other daily activities, are provided in the fourth column of Table

4. Here, both the intake of fruit and vegetables are found to positively influence respondent scores; with the optimal amounts estimated at 3-4 portions of fruit and up to 5 portions of vegetables a day.

4.4.3 Vitality

Estimation results for the overall measure of vitality, defined as the state of being strong and active, is presented in column 5 of Table 4. The coefficient estimates indicate a positive and statistically significant effect of fruit consumption on the Vitality index; with the latter score being on average 2.41 points higher for individuals consuming 4 to 5 servings of fruit per day, as opposed to those consuming less than 1 serving per day. An estimated vegetable gradient, which is about half the size of the corresponding fruit gradient, is also apparent (at the 10% level of significance). Overall, the average vitality level of respondents is found to peak once they consume about 4-5 portions of fruit and 4-5 portions of vegetables a day.

Examining some of the more specific measures/items of vitality (Table 6, columns 5 to 7); individuals eating 4-5 daily servings of fruit report higher 'physical energy' scores (column 5), while consuming any amount of vegetables does not entail such positive vitality effects. Additionally, the intake of fruit and vegetables increases average scores for the 'felt full of life' measure (column 6), and at the same time decreases average scores for the 'felt worn out' measure (column 7). The former vitality proxy is estimated to peak at 2-3 daily portions of fruit and 4-5 daily portions of vegetables, while the latter is minimised at approximately 4-5 servings of fruit and 4-5 servings of vegetables a day. In general, fruit and vegetables are each found to independently influence people's vitality levels.

4.5 Other Physical Well-being Scores

In this final subsection, I investigate whether some more distinct measures of individual physical health, namely the Physical Functioning, Role Physical and Bodily Pain indices, are

influenced by the intake of slightly more or less (than average) fruits and vegetables. The results are presented in columns 6 to 8 of Table 4. While there is no evidence of statistically significant positive impacts for the last two measures, there is some evidence of a potential placebo effect under the Physical Functioning domain (column 6). That is, individuals who consume, on average, 2-3 portions of fruit and 3-4 portions of vegetable per day tend to report higher physical functioning scores than those who eat close to zero portions a day.

Lastly, there are no significant estimated effects of fruit and vegetable consumption on body weight as approximated by self-reported BMI; hence, rejecting the latter measure as a potential pathway between healthy eating and well-being. Although perhaps surprising, this finding is consistent with several previous empirical studies on the topic (Field et al. 2003; Charlton et al. 2014).

5. Conclusions

Are fruit and vegetables good for our mental and physical health? Based on nationally representative longitudinal data from Australia, the estimation results indicate fruit and vegetable consumption to positively and independently influence a wide range of self-reported mental and physical well-being measures, even after controlling for individual fixed effects. For example, in terms of life satisfaction or happiness levels, the optimal consumption bundle is predicted to be at '5 or more' portions of fruit and '4 to 5' portions of vegetables a day; implying a combined bundle of more than 9 daily portions. Similar optimal fruit and vegetable baskets are estimated for self-assessed health (7-9 serves; 3-4 fruits & 4-5 vegetables); general health (7-9 serves; 3-4 fruits & 4-5 vegetables); and vitality scores (8-10 serves; 4-5 fruits & 4-5 vegetables).

While the daily intake of both fruit and vegetables is found to matter for the above health measures, the sole consumption of fruit (as opposed to vegetables) is estimated to have

more profound effects on distinct indicators of emotional well-being, such as the overall mental health and psychological distress scores (peaking at about 4-5 daily portions). On the other hand, the intake of vegetables alone is found to have relatively larger impacts on selected general health items, namely for those scores which broadly capture social comparisons in self-reported health. Significant gender differences are also apparent in life satisfaction and self-assessed health ratings, with the estimated fruit and vegetable gradients being stronger for female than male respondents.

The notable change (reduction) in the estimated coefficients between the pooled OLS and linear fixed effects models suggests there to be biases due to not controlling for individual fixed effects, i.e. evidence of positive selection with respect to time-invariant unobserved characteristics. After controlling for fixed effects, there appear to be clear optimum levels of fruit and vegetable consumption (for many of the well-being measures); with no evidence of any monotonic associations. That is, eating either 'too few' or 'too many' fruits and vegetables is not good for self-reported well-being. Such biases and findings are mostly overlooked with cross-sectional data.

The found results have implications for both government policy-makers and health professionals; in that, fruit and vegetable consumption should be considered in public policy design aimed at improving people's mental, and not only physical, levels of health. At the same time, the current findings suggest the traditional 5-a-day healthy-eating guidelines to be somewhat inadequate, with growing empirical evidence indicating optimal consumption levels of closer to 8-10 combined daily portions. The general findings in this paper are consistent with several other empirical studies recently conducted in different parts of the world (see Blanchflower et al. 2013; White et al. 2013; and Oyebode et al. 2014).

Overall, less than one-quarter of the Australian adult population consumes the optimal amount and mix of fruit and vegetables each day. At the same time, the '2+5' campaign

undertaken by the Australian government, along with the '5-to-10-a-day' strategy in place across Canada, arguably comes closest to the estimated optimal consumption basket. However, as is the case with the standard 5-a-day rule (for physical health), these guidelines are in need of a review. The findings in this study especially point towards the promotion of higher levels of fruit consumption than historically undertaken.

Finally, the estimated independent effects of fruit and vegetables on selected psychological well-being measures, in addition to the apparent gender heterogeneity, imply more complex and targeted policy interventions. Further research on this topic using richer longitudinal data sources that record people's eating and lifestyle choices at more regular intervals over time, as well as the implementation of experimental methods in the form of large-scale randomised control trials, is bound to be fruitful for individual and societal well-being.

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Table 1: Summary of Mental and Physical Well-being Measures

Score / Index	Mean	SD	Min	Max	*N*
Life Satisfaction	7.91	1.41	0	10	20,127
Self-Assessed Health	3.42	0.96	1	5	19,787
General Health	69.23	20.92	0	100	19,916
Mental Health	74.80	16.79	0	100	20,104
Psychological Distress	15.53	6.06	10	50	20,098
Role Emotional	84.23	31.99	0	100	19,713
Ever told by doctor to have depression or anxiety	0.17	0.37	0	1	19,144
Vitality	60.36	19.67	0	100	20,101
Physical Functioning	84.10	22.48	0	100	19,767
Role Physical	79.58	35.70	0	100	19,743
Bodily Pain	73.54	23.89	0	100	19,854
Body Mass Index	26.59	5.66	9.6	85.3	20,136

Notes: General Health: 0 = Very poor levels of personal health and health expectations; 100 = Excellent levels of personal health and health expectations. *Mental Health*: 0 = Feelings of nervousness and depression all of the time; 100 = Feels peaceful, happy, and calm all of the time. *Psychological Distress*: 0 = Feelings of nervousness, hopelessness, restlessness and depression all of the time; 100 = Feels calm, relaxed, content and satisfied all of the time. *Role Emotional*: 0 = Problems with work or other daily activities as a result of emotional problems; 100 = No problems with work or other daily activities as a result of emotional problems. *Vitality*: 0 = Feels tired and worn out all of the time; 100 = Feels full of liveliness and energy all of the time. *Physical Functioning*: 0 = Extremely limited in performing all physical function activities because of physical health; 100 = Performs physical function activities with ease. *Role Physical*: 0 = Extreme difficulty in performing work or regular daily activities due to physical problems; 100 = No issues with work or regular daily activities due to physical problems. *Bodily Pain*: 0 = No bodily pain and interference; 100 = Extreme bodily pain and interference. The more objective measure of mental health (diagnosis of depression/anxiety) is based on the following question: (i) 'Have you ever been told by a doctor or nurse that you have any of the long-term health conditions listed below? Please only include those conditions that have lasted or are likely to last for 6 months or more: Depression/Anxiety'.

Table 2: Effects of Fruit and Vegetable Consumption on Self-Reported Life Satisfaction

	OLS			Fixed Effects		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Fruit (per day)						
1-2 portions	0.126***	0.084***	0.035	0.028	0.026	0.011
	[0.024]	[0.024]	[0.026]	[0.029]	[0.029]	[0.033]
2-3 portions	0.202***	0.135***	0.058**	0.039	0.043	0.029
	[0.024]	[0.025]	[0.027]	[0.035]	[0.035]	[0.039]
3-4 portions	0.202***	0.133***	0.042	0.026	0.015	0.037
	[0.032]	[0.033]	[0.035]	[0.046]	[0.047]	[0.053]
4-5 portions	0.232***	0.192***	0.080	0.085	0.124*	0.123
	[0.053]	[0.053]	[0.056]	[0.068]	[0.071]	[0.082]
5 or more portions	0.295***	0.214***	0.154**	0.157*	0.148	0.201*
	[0.068]	[0.068]	[0.073]	[0.093]	[0.097]	[0.111]
Vegetables (per day)						
1-2 portions	0.198***	0.185***	0.126***	0.114***	0.104**	0.062
	[0.030]	[0.030]	[0.033]	[0.039]	[0.044]	[0.047]
2-3 portions	0.290***	0.263***	0.199***	0.154***	0.134***	0.088*
	[0.029]	[0.030]	[0.032]	[0.042]	[0.047]	[0.050]
3-4 portions	0.366***	0.321***	0.235***	0.122***	0.108**	0.082
	[0.032]	[0.032]	[0.035]	[0.046]	[0.050]	[0.053]
4-5 portions	0.464***	0.431***	0.337***	0.175***	0.167***	0.153***
	[0.037]	[0.037]	[0.040]	[0.050]	[0.054]	[0.058]
5 or more portions	0.448***	0.450***	0.344***	0.096*	0.092	0.076
	[0.042]	[0.042]	[0.045]	[0.057]	[0.062]	[0.065]
Other demographic controls	No	Yes	Yes	No	Yes	Yes
Other dietary & lifestyle controls	No	No	Yes	No	No	Yes
R-squared	0.017	0.077	0.101	0.012	0.009	0.031
Individuals	14,645	14,098	12,385	14,645	14,098	12,385
Observations	26,049	24,716	20,127	26,049	24,716	20,127

Notes: Figures are estimated coefficients. Standard errors clustered at the individual-level are shown in parentheses. *, ** and *** denote significance at the .10, .05 and .01 levels. Base categories: Less than 1 portion of fruit per day; less than 1 portion of vegetables per day. Other demographic and dietary/lifestyle controls are listed in Tables A3 and A4 of the Appendix.

Table 3: Effects of Fruit and Vegetable Consumption on Self-Assessed Health

	OLS			Fixed Effects		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Fruit (per day)						
1-2 portions	0.078***	0.100***	0.038**	0.061***	0.067***	0.062***
	[0.017]	[0.015]	[0.016]	[0.018]	[0.019]	[0.020]
2-3 portions	0.064***	0.134***	0.037**	0.054**	0.063***	0.043*
	[0.018]	[0.016]	[0.016]	[0.021]	[0.022]	[0.024]
3-4 portions	0.088***	0.190***	0.083***	0.087***	0.085***	0.075**
	[0.023]	[0.021]	[0.021]	[0.028]	[0.029]	[0.030]
4-5 portions	0.100***	0.192***	0.072**	0.016	0.037	0.034
	[0.038]	[0.034]	[0.034]	[0.041]	[0.043]	[0.046]
5 or more portions	0.145***	0.190***	0.092**	-0.004	0.015	0.009
	[0.049]	[0.044]	[0.044]	[0.053]	[0.055]	[0.061]
Vegetables (per day)						
1-2 portions	0.101***	0.086***	0.055***	0.045*	0.053**	0.038
	[0.022]	[0.020]	[0.020]	[0.023]	[0.024]	[0.026]
2-3 portions	0.132***	0.147***	0.109***	0.047*	0.053**	0.035
	[0.021]	[0.019]	[0.019]	[0.025]	[0.026]	[0.028]
3-4 portions	0.132***	0.191***	0.131***	0.059**	0.072**	0.060**
	[0.023]	[0.021]	[0.021]	[0.027]	[0.028]	[0.030]
4-5 portions	0.138***	0.234***	0.151***	0.089***	0.107***	0.087***
	[0.027]	[0.024]	[0.024]	[0.030]	[0.031]	[0.033]
5 or more portions	0.145***	0.298***	0.178***	0.053	0.067*	0.030
	[0.030]	[0.027]	[0.027]	[0.035]	[0.036]	[0.038]
Other demographic controls	No	Yes	Yes	No	Yes	Yes
Other dietary & lifestyle controls	No	No	Yes	No	No	Yes
R-squared	0.005	0.253	0.308	0.004	0.014	0.003
Individuals	13,341	12,832	12,292	13,341	12,832	12,292
Observations	22,494	21,365	19,787	22,494	21,365	19,787

Notes: Figures are estimated coefficients. Standard errors clustered at the individual-level are shown in parentheses. *, ** and *** denote significance at the .10, .05 and .01 levels. Base categories: Less than 1 portion of fruit per day; less than 1 portion of vegetables per day. Other demographic and dietary/lifestyle controls are listed in Tables A3 and A4 of the Appendix.

Table 4: Effects of Fruit and Vegetable Consumption on Mental and Physical Well-being Indices

	General Health	Mental Health	Psychological Distress	Role Emotional	Vitality	Physical Functioning	Role Physical	Bodily Pain	Body Mass Index
Fruit (per day)									
1-2 portions	0.881**	-0.120	-0.007	-1.057	0.260	0.721*	-0.888	-0.181	0.062
	[0.365]	[0.380]	[0.129]	[0.853]	[0.411]	[0.419]	[0.857]	[0.524]	[0.087]
2-3 portions	0.766*	0.780*	-0.181	0.366	1.047**	1.602***	-0.046	0.023	-0.012
	[0.428]	[0.443]	[0.149]	[1.003]	[0.488]	[0.505]	[1.076]	[0.644]	[0.098]
3-4 portions	1.230**	1.349**	-0.253	2.269*	1.001	0.906	0.580	-0.418	-0.073
	[0.559]	[0.568]	[0.188]	[1.296]	[0.615]	[0.641]	[1.415]	[0.821]	[0.131]
4-5 portions	0.979	1.613**	-0.493*	1.222	2.408***	0.641	-0.199	-0.536	0.019
	[0.841]	[0.793]	[0.257]	[1.798]	[0.888]	[0.849]	[2.026]	[1.166]	[0.214]
5 or more portions	-0.355	1.685	-0.521	2.407	0.741	0.688	0.371	-1.374	0.142
	[1.150]	[1.080]	[0.334]	[2.165]	[1.239]	[1.218]	[2.673]	[1.564]	[0.241]
Vegetables (per day)									
1-2 portions	0.828*	0.444	0.041	2.167**	0.817	1.223**	0.681	0.336	0.007
	[0.468]	[0.502]	[0.175]	[1.084]	[0.547]	[0.549]	[1.067]	[0.684]	[0.154]
2-3 portions	0.717	0.033	0.017	1.362	0.407	1.006*	0.009	0.272	0.043
	[0.496]	[0.529]	[0.183]	[1.171]	[0.580]	[0.577]	[1.156]	[0.717]	[0.190]
3-4 portions	1.054*	0.089	0.048	2.887**	0.753	1.292**	0.725	-0.144	0.005
	[0.550]	[0.576]	[0.195]	[1.267]	[0.627]	[0.649]	[1.275]	[0.781]	[0.179]
4-5 portions	1.279**	0.120	-0.057	2.701*	1.151*	1.070	-0.220	0.302	0.012
	[0.598]	[0.632]	[0.211]	[1.403]	[0.696]	[0.709]	[1.417]	[0.881]	[0.187]
5 or more portions	0.447	-0.186	0.091	1.369	0.589	0.919	-0.059	-1.064	-0.196
	[0.700]	[0.692]	[0.227]	[1.569]	[0.801]	[0.853]	[1.620]	[1.008]	[0.210]
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.059	0.031	0.041	0.040	0.093	0.312	0.156	0.146	0.038
Individuals	12,316	12,375	12,378	12,266	12,374	12,291	12,276	12,319	12,389
Observations	19,916	20,104	20,098	19,713	20,101	19,767	19,743	19,854	20,136

Notes: Figures are estimated coefficients. Standard errors clustered at the individual-level are shown in parentheses. *, ** and *** denote significance at the .10, .05 and .01 levels. Base categories: Less than 1 portion of fruit per day; less than 1 portion of vegetables per day. Other demographic and dietary/lifestyle controls are listed in Tables A3 and A4 of the Appendix.

Table 5: Effects of Fruit and Vegetable Consumption on Selected SF-36 Mental Health and Psychological Distress Items

	Been a happy person	Felt calm and peaceful	Felt so down in the dumps nothing could cheer you up	Felt so sad that nothing could cheer you up	Felt tired out for no good reasons	Felt depressed	Ever told by doctor to have depression or anxiety
Fruit (per day)							
1-2 portions	-0.006	0.019	-0.005	0.004	-0.037	0.030	0.021**
	[0.027]	[0.031]	[0.025]	[0.019]	[0.024]	[0.021]	[0.009]
2-3 portions	0.053*	0.078**	-0.005	-0.021	-0.064**	-0.006	0.003
	[0.031]	[0.038]	[0.029]	[0.022]	[0.028]	[0.025]	[0.010]
3-4 portions	0.094**	0.092**	-0.043	-0.041	-0.047	-0.023	0.008
	[0.041]	[0.047]	[0.037]	[0.028]	[0.036]	[0.031]	[0.012]
4-5 portions	0.162***	0.043	-0.108**	-0.095***	-0.145***	-0.063	0.027
	[0.061]	[0.069]	[0.052]	[0.037]	[0.052]	[0.045]	[0.018]
5 or more portions	0.134*	0.001	-0.102	-0.141***	-0.144**	-0.026	0.001
	[0.080]	[0.095]	[0.076]	[0.055]	[0.068]	[0.058]	[0.024]
Vegetables (per day)							
1-2 portions	-0.027	0.078*	-0.022	0.004	-0.008	0.005	0.010
	[0.036]	[0.040]	[0.035]	[0.025]	[0.033]	[0.029]	[0.011]
2-3 portions	-0.006	0.030	-0.010	-0.004	-0.034	-0.018	0.012
	[0.038]	[0.043]	[0.038]	[0.026]	[0.034]	[0.030]	[0.012]
3-4 portions	-0.022	0.022	0.004	-0.020	-0.015	-0.011	0.008
	[0.042]	[0.046]	[0.041]	[0.028]	[0.038]	[0.032]	[0.013]
4-5 portions	-0.010	0.072	-0.009	-0.017	-0.039	-0.019	-0.002
	[0.045]	[0.051]	[0.044]	[0.030]	[0.041]	[0.035]	[0.014]
5 or more portions	0.026	0.069	0.024	-0.012	0.009	0.004	0.018
	[0.051]	[0.057]	[0.050]	[0.032]	[0.047]	[0.039]	[0.017]
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.026	0.033	0.022	0.027	0.006	0.019	0.007
Individuals	12,360	12,356	12,354	12,371	12,376	12,371	12,057
Observations	20,054	20,060	20,047	20,078	20,087	20,076	19,144

Notes: Figures are estimated coefficients. Standard errors clustered at the individual-level are shown in parentheses. *, ** and *** denote significance at the .10, .05 and .01 levels. Base categories: Less than 1 portion of fruit per day; less than 1 portion of vegetables per day. Other demographic and dietary/lifestyle controls are listed in Tables A3 and A4 of the Appendix.

Table 6: Effects of Fruit and Vegetable Consumption on Selected SF-36 General Health and Vitality Items

	As healthy as anybody I know	Get sick a little easier than other people	Expect my health to get worse	Health compared to one year ago	Had a lot of energy	Felt full of life	Felt worn out
Fruit (per day)							
1-2 portions	0.034	-0.017	-0.040	0.010	-0.008	0.019	-0.004
	[0.024]	[0.023]	[0.025]	[0.022]	[0.028]	[0.028]	[0.029]
2-3 portions	0.033	-0.010	-0.066**	0.033	0.062*	0.070**	-0.014
	[0.029]	[0.026]	[0.029]	[0.026]	[0.033]	[0.033]	[0.034]
3-4 portions	0.047	0.023	-0.114***	0.091***	0.056	0.067	-0.039
	[0.038]	[0.035]	[0.038]	[0.034]	[0.042]	[0.043]	[0.044]
4-5 portions	0.074	-0.003	-0.146**	0.122**	0.150***	0.095	-0.121*
	[0.059]	[0.049]	[0.058]	[0.053]	[0.058]	[0.062]	[0.067]
5 or more portions	-0.020	0.022	-0.002	0.109	0.072	0.113	0.040
	[0.078]	[0.067]	[0.076]	[0.069]	[0.082]	[0.084]	[0.091]
Vegetables (per day)							
1-2 portions	0.039	-0.058**	-0.018	0.007	-0.011	0.061*	-0.049
	[0.031]	[0.029]	[0.032]	[0.028]	[0.037]	[0.037]	[0.038]
2-3 portions	0.041	-0.066**	-0.010	0.024	-0.020	0.064*	-0.028
	[0.033]	[0.031]	[0.034]	[0.030]	[0.039]	[0.038]	[0.041]
3-4 portions	0.080**	-0.045	0.007	0.030	-0.037	0.057	-0.087**
	[0.037]	[0.034]	[0.037]	[0.032]	[0.042]	[0.041]	[0.044]
4-5 portions	0.088**	-0.060	-0.027	0.022	-0.003	0.106**	-0.082*
	[0.041]	[0.037]	[0.042]	[0.036]	[0.047]	[0.047]	[0.049]
5 or more portions	0.046	-0.027	0.023	0.043	-0.063	0.032	-0.113**
	[0.048]	[0.041]	[0.049]	[0.041]	[0.053]	[0.053]	[0.057]
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.072	0.034	0.062	0.060	0.095	0.085	0.034
Individuals	12,331	12,319	12,318	12,298	12,355	12,363	12,342
Observations	19,971	19,922	19,918	19,801	20,029	20,082	20,010

Notes: Figures are estimated coefficients. Standard errors clustered at the individual-level are shown in parentheses. *, ** and *** denote significance at the .10, .05 and .01 levels. Base categories: Less than 1 portion of fruit per day; less than 1 portion of vegetables per day. Other demographic and dietary/lifestyle controls are listed in Tables A3 and A4 of the Appendix.

Appendix

Table A1: Distribution of Average Daily Fruit Consumption

Portions of fruit per day (average amount based on weekly intake)	**% of the total sample**
None	6.12
> 0 but less than 1	34.94
1 portion or more but less than 2	21.51
2 portions or more but less than 3	22.11
3 portions or more but less than 4	10.26
4 portions or more but less than 5	3.22
5 or more portions	1.83

Note: Sample size used to calculate summary statistics equals 20,136.

Table A2: Distribution of Average Daily Vegetable Consumption

Portions of vegetables per day (average amount based on weekly intake)	**% of the total sample**
None	0.62
> 0 but less than 1	13.03
1 portion or more but less than 2	21.46
2 portions or more but less than 3	27.10
3 portions or more but less than 4	19.05
4 portions or more but less than 5	11.00
5 or more portions	7.75

Note: Sample size used to calculate summary statistics equals 20,136.

Table A3: Summary of Demographic and Socioeconomic Control Variables

Variable	Description	Mean	SD	Min	Max
Age	Years of age	45.16	17.89	15	93
Age-squared	Years of age squared, divided by 100	23.59	17.37	2.25	86.49
Income	Log of equivalized household income	10.15	1.02	0	13.01
Male		0.47	0.50	0	1
Full-time student		0.07	0.26	0	1
Education dummy 1	Masters or doctorate	0.04	0.19	0	1
Education dummy 2	Bachelor or honours	0.14	0.34	0	1
Education dummy 3	Grad diploma, grad certificate	0.06	0.23	0	1
Education dummy 4	Advanced diploma, diploma	0.09	0.29	0	1
Education dummy 5	Professional qualification (any certificate I, II, III, IV)	0.22	0.41	0	1
Education dummy 6	Year 12	0.15	0.36	0	1
Education dummy 7	Year 11 and below (baseline category)	0.30	0.46	0	1
Employment status 1	Unemployed	0.03	0.16	0	1
Employment status 2	Not in the labour force	0.30	0.46	0	1
Employment status 3	Employed (baseline category)	0.68	0.47	0	1
Married		0.51	0.50	0	1
Separated		0.03	0.18	0	1
Divorced		0.10	0.29	0	1
Widowed		0.05	0.22	0	1
Long-term health issues	Have a long-term health condition, disability or impairment	0.23	0.42	0	1
Number of children 1	Number of children under the age of 4	0.16	0.48	0	4
Number of children 2	Number of children between the ages of 5 and 14	0.31	0.71	0	6

Note: Sample size used to calculate summary statistics equals 20,136.

Table A4: Summary of Other Dietary and Lifestyle Control Variables

Variable	Description	Mean	SD	Min	Max
BMI	Body Mass Index [weight in kg / (height in m)^2]	26.59	5.66	9.6	85.3
Alcohol intake 1	Drink alcohol: never, no longer, or rarely (baseline category)	0.38	0.48	0	1
Alcohol intake 2	Drink alcohol 1 or 2 days per week	0.20	0.40	0	1
Alcohol intake 3	Drink alcohol 2 or 3 days per week	0.12	0.32	0	1
Alcohol intake 4	Drink alcohol 3 or 4 days per week	0.14	0.35	0	1
Alcohol intake 5	Drink alcohol 5 or 6 days per week	0.09	0.29	0	1
Alcohol intake 6	Drink alcohol everyday	0.08	0.27	0	1
Non-smoker	Do not smoke cigarettes at all	0.80	0.40	0	1
Regular physical exercise	Exercise at least three times a week per week; moderately to intensively	0.51	0.50	0	1
Eat breakfast regularly	Eat breakfast seven times a week	0.70	0.46	0	1
Low fat/skim milk	Drink low fat or skinny milk	0.49	0.50	0	1
Avoid fatty foods	Eat fried potatoes, French fires, hot chips or wedges less than once a month	0.26	0.44	0	1
No fish intake	Never eat fresh, frozen, tinned fish, or shellfish	0.11	0.31	0	1
No meat intake	Never eat red meat (beef, veal, lamb, pork)	0.03	0.17	0	1

Note: Sample size used to calculate summary statistics equals 20,136.

Table A5: Life Satisfaction and Self-Assessed Health FE Regressions, Males & Females

	Life Satisfaction			Self-Assessed Health		
	All	**Males**	**Females**	**All**	**Males**	**Females**
Fruit (per day)						
1-2 portions	0.011	-0.005	0.028	0.062***	0.041	0.082***
	[0.033]	[0.041]	[0.051]	[0.020]	[0.027]	[0.029]
2-3 portions	0.029	0.037	0.030	0.043*	0.010	0.074**
	[0.039]	[0.052]	[0.058]	[0.024]	[0.035]	[0.032]
3-4 portions	0.037	0.030	0.041	0.075**	0.014	0.121***
	[0.053]	[0.075]	[0.074]	[0.030]	[0.045]	[0.041]
4-5 portions	0.123	-0.027	0.213*	0.034	-0.039	0.100
	[0.082]	[0.105]	[0.122]	[0.046]	[0.068]	[0.062]
5 or more portions	0.201*	0.249	0.127	0.009	-0.026	0.042
	[0.111]	[0.156]	[0.156]	[0.061]	[0.082]	[0.089]
Vegetables (per day)						
1-2 portions	0.062	0.097	0.015	0.038	0.032	0.047
	[0.047]	[0.060]	[0.075]	[0.026]	[0.035]	[0.038]
2-3 portions	0.088*	0.150**	0.025	0.035	0.021	0.050
	[0.050]	[0.063]	[0.079]	[0.028]	[0.038]	[0.040]
3-4 portions	0.082	0.089	0.074	0.060**	0.013	0.102**
	[0.053]	[0.068]	[0.083]	[0.030]	[0.042]	[0.043]
4-5 portions	0.153***	0.085	0.187**	0.087***	0.019	0.144***
	[0.058]	[0.077]	[0.089]	[0.033]	[0.048]	[0.046]
5 or more portions	0.076	0.129	0.038	0.030	0.022	0.048
	[0.065]	[0.091]	[0.097]	[0.038]	[0.055]	[0.053]
Other demographic controls	Yes	Yes	Yes	Yes	Yes	Yes
Other dietary & lifestyle controls	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.031	0.017	0.025	0.003	0.066	0.010
Individuals	12,385	5,862	6,523	12,292	5,819	6,473
Observations	20,127	9,521	10,606	19,787	9,355	10,432

Notes: Figures are estimated coefficients. Standard errors clustered at the individual-level are shown in parentheses. *, ** and *** denote significance at the .10, .05 and .01 levels. Base categories: Less than 1 portion of fruit per day; less than 1 portion of vegetables per day. Other demographic and dietary/lifestyle controls are listed in Tables A3 and A4 of the Appendix.

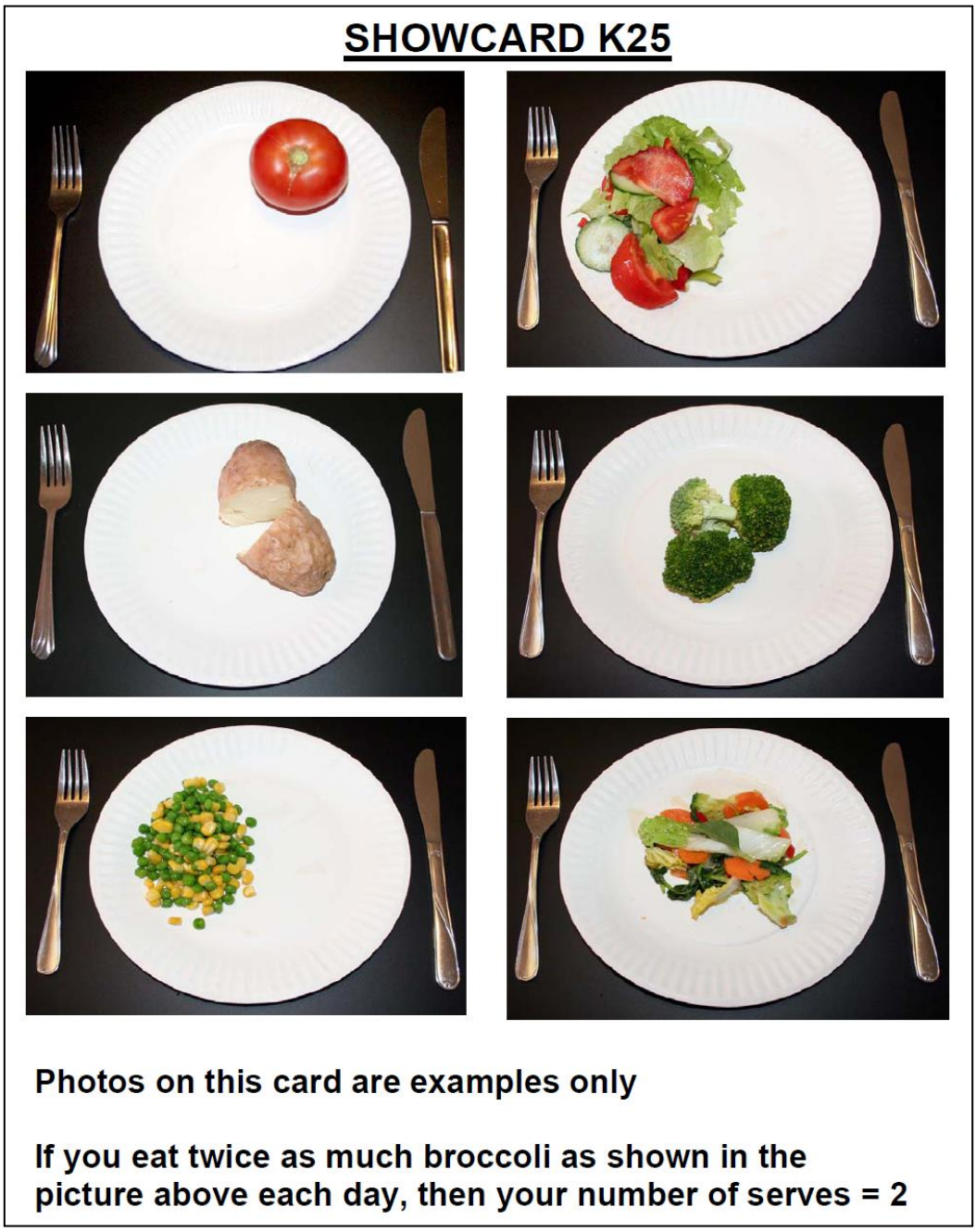

Figure A1: Vegetable servings size (Showcard K25, HILDA Survey, Waves 7 and 9)

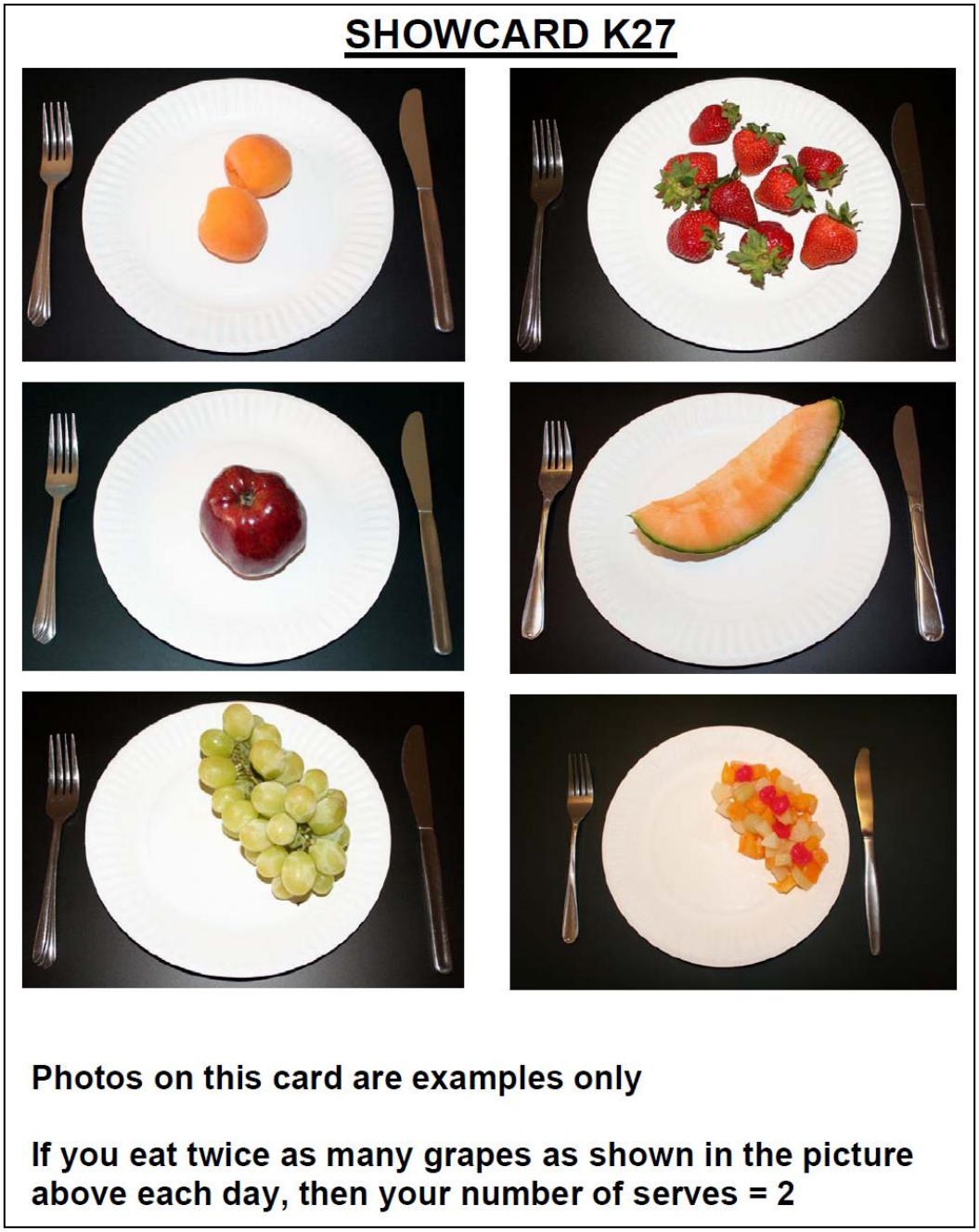

Figure A2: Fruit servings size (Showcard K27, HILDA Survey, Waves 7 and 9)