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Evolution in Well-being and Happiness after Increases in Consumption of Fruit and Vegetables

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Abstract

OBJECTIVES

To explore whether improvements in psychological well-being occur after increases in fruit and vegetable consumption.

METHODS

Longitudinal food diaries were examined on 12,000 randomly-sampled Australian adults over 2007, 2009, and 2013. The study estimated fixed-effects regression equations on individuals' happiness and life satisfaction. It adjusted for a large set of other influences, including people's changing incomes and personal circumstances. Prospective analysis, Granger-causality tests, and instrumental-variable estimation were also done.

RESULTS

Increases in fruit and vegetable intake were predictive of increases in happiness and life satisfaction. Well-being improvements were of up to 0.24 life-satisfaction points (for an increase of 8 portions a day), which is equal in size to the psychological gain of moving from unemployment to employment. Improvements occurred within 24 months.

CONCLUSIONS

People's motivation to eat healthy food is weakened by the fact that physical-health benefits accrue decades later. This study offers a new possibility. Public-health policy could emphasize immediate well-being improvement from healthy eating.

POLICY IMPLICATIONS

Citizens could be shown longitudinal evidence that 'happiness' gains from healthy eating can occur quickly and many years before enhanced physical health.

Fruit and vegetables are known to provide important health benefits (*1, 2*). Yet in Western society the typical citizen eats an unhealthy diet (US data are available at www.cdc.gov/brfss and European data at www.eufic.org). The difficulty of persuading people to consume more fruit and vegetables remains a serious one (*3-7*).

This study explores a new approach to the problem. The paper is designed partly for the scientific researcher and partly for the public-health practitioner. It uncovers evidence consistent with a longitudinal connection between the consumption of certain foods (especially fruit and vegetables) and later subjective well-being, and a channel that appears to be independent of long-run health.

In disciplines beyond public-health research, the study of happiness and well-being has generated a large modern literature. It is summarized in sources such as *8, 9*. The potential influence of food has been virtually ignored. Traditional research on well-being has focused upon the role of economic, personal, and political influences (see e.g. *9, 10, 11*) and in character has been steadily moving in emphasis from cross-sectional to longitudinal analysis (e.g. *12*). That the scholarly literature has developed in the way described is perhaps unsurprising. First, most data sets do not record information on the foods eaten by individuals; second, the main contributors to the happiness and well-being literature have been researchers from the classic social-science disciplines. Hence it is perhaps understandable that the role of food in the list of determinants of well-being has so far been given little attention, even though, in an important line of work, researchers (such as *13*) have, within a different literature, drawn attention to the potential social significance of diet.

The present study uses a representative panel of 12,000 individuals to trace the potential linkages running from diet to later life satisfaction and happiness. It is intended as a complement to the aforementioned literature on socio-economic influences. In its style, the study fits within an emerging panel-data literature on human well-being. The analysis is first done by following individuals between 2007 and 2009. Just as the project was completed, however, new data were released, which makes it possible to check the calculations also for the period 2009 to 2013 (these replication findings are reported in supplemental tables S9-S11).

There are precursors to this paper. Innovative research by Tamlin Conner and collaborators (*14*) has found -- using data on daily food diaries on 281 students tracked over a three-week period -- that a high level of fruit and vegetable consumption appears to be predictive of greater emotional well-being on the following day. Various cross-sectional papers have also pointed to the possible existence of a statistical connection between psychological well-being and the amount of fruit and vegetables eaten, and have shown that

this correlation survives the inclusion of a large number of covariates (*15*).

There is also a small longitudinal literature which suggests there may be positive benefits from a high intake of fruit and vegetables, although, crucially, that literature has not been able to control for some of the key confounders such as individuals' levels of income (*16-19*). There have also been three important small randomized controlled trials: on nutritional counseling and on the provision of healthy food and snacks (*20*, *21*, *22*), which find some evidence that a higher intake of fruit and vegetables may be associated with improved psychological health (as well as physical health). Another set of writings has tried to understand obesity and its links to subjective well-being (e.g. *23*, *24*). These suggest that there is an inverse -- although relatively small -- correlation between body mass index BMI and mental well-being.

This paper documents not cross-sectional patterns but rather the longitudinal (the so-called 'change-on-change') linkages between fruit and vegetable consumption and mental well-being; such an approach helps ensure that any observed relationship is not merely a spurious cross-sectional pattern caused by omitted confounding factors such as personality, background wealth, or prior family upbringing. Cognizant of the work of others (*25*), this paper examines whether the level of fruit and vegetable consumption today is predictive of the level of later well-being, while inquiring into reverse-causality concerns hitherto unaddressed in the happiness literature.

METHODS

The main 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 began in 2001. The HILDA Survey collects annual longitudinal information from members of Australian households who are at least 15 years of age. It provides information on a total of 13,969 individuals from 7,682 different households interviewed since the first wave. Data are collected each year by face-to-face interviews and self-completion questionnaires. The former technique is mainly used to gather the demographic and socio-economic information, while the latter is adopted to measure health and lifestyle choices.

After excluding respondents with missing information on the key outcome and control variables, the total sample available for this study consists of 12,389 individuals (aged 15 to 93) and 20,136 person-year observations. No observations are deliberately dropped. As would be expected, however, the sample sizes vary slightly across the different well-being measures.

Two questions relating to fruit and vegetable consumption are available in Waves 7 and 9. The corresponding questionnaires ask:

- *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 who respond with some positive frequency to the questions above, the following is also asked:

- *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?*

The survey respondents are shown flashcards to visually define a serving size or portion (photographs of these are given as Figures S3-S4 in the Supplemental Material), with possible answers ranging from '1' to '6 or more' portions. This visual approach is for simplicity and clarity (see, e.g., *26*). We multiply the responses to the above paired (frequency and quantity) questions to form a weekly consumption amount of fruit and vegetables, respectively. We then divide each resulting product by seven to arrive at the average daily amount. The average intake of fruit by each survey respondent is then added to their average intake of vegetables to compute the combined average daily consumption of fruit and vegetables. The mean value is 3.84 serves per day with a standard deviation of 2.01. Some respondents said they did not consume any fruit or vegetables in a typical week. This group forms the 'none' or 'zero' consumption category. Approximately 85% of respondents have fewer than 3 daily servings of fruit; 60% consume fewer than 3 daily servings of vegetables. A small fraction of people consume, on average, both more than 5 servings of fruit (1.83%) or vegetables (7.75%) each day. Table S8 contains more detailed summary statistics on the separate fruit and vegetable intake measures.

The first dependent variable examined is self-reported life satisfaction, 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*". 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 life satisfaction score of more than 7 out of 10. As an additional check, a second measure is used. A generic health variable available in the HILDA data set is the Medical Outcomes Short Form (SF-36) Questionnaire. The SF-36 is a one of the most widely used and validated self-completion measures of health status available, consisting of 36 items/questions; 35 of them are used to derive eight health subscales/indices. The respondent is asked '*how much of the time in the past four weeks..'* did he/she experience particular types of feelings/symptoms, including '*… been a happy person'*. The resulting response distribution for the latter question is as follows: 1% (None of the time); 4.8% (A little of the time); 13.9% (Some of the time); 19.5% (A good bit of the time); 51.9% (Most of the time); 8.9% (All of the time). The individuals' responses are coded as from 1 (None of the time) to 6 (All of the time), with a mean happiness score of 4.43 out of 6.

RESULTS

Figure 1 is a simple graphical illustration of the study's key result for life satisfaction. A similar histogram holds also for happiness data. The plot in Figure 1 is based on a so-called fixed-effect regression equation. It depicts the (uncorrected) longitudinal relationship -- the change-on-change relationship -- between people's subjective well-being and nine different levels of fruit and vegetable consumption. Further descriptive information is provided in the Supplemental Material. Alternative kinds of scatter plots are given as Figures S1 and S2 in that material.

The regression analyses reported in Table 1 provide formal evidence. These correct for other influences following sources such as (*8*) and (*27*). The key coefficient in the first column of Table 1 is 0.03 ($\beta = 0.03$, 95% confidence interval, or CI = [0.01, 0.04], $p = .002$). This implies that a change from the lowest levels to the highest levels of fruit and vegetable consumption would, on average, be associated with a rise in life satisfaction of approximately 0.24 life-satisfaction points.

The implied effect-size is substantial. At first glance, the number 0.24 might be thought to indicate that the consequences of fruit and vegetable intake are minor. That interpretation is mistaken; it stems from a blurring of the distinction between inter-person variance and intra-person variance. As in much of the longitudinal public-health research, this study tries to understand not the (inevitably high) cross-sectional variation in human well-being but instead intra-person changes that might be capable of being influenced by public interventions. In column 1 of Table 1, this requires that a number such as 0.24 (which is 8 times the coefficient

of 0.03) has to be added to the number 7.81. As can be seen from the later right-hand-side columns of Table 1, the effect is the equivalent in absolute size to (in the negative direction) that of becoming unemployed or approximately half the size of the emotional consequence of marital separation. Such an effect-size is large.

If Model 1 of Table 1 were the only regression result available, it would be plausible to believe that the relationship is spurious. It might be being driven by omitted variables -- for example, someone, say, becoming richer through time and becoming happier and simultaneously eating in a healthier way because they could now afford it, or, say, divorcing a spouse and becoming less happy and also eating in a less healthy way. However, the later columns of Table 1 imply that such interpretations would be incorrect. The analyses here include extra covariates: the natural logarithm of household income, age, education, whether working, marital status, health, children, alcohol and food patterns, Body Mass Index, and exercise (for a detailed specification of these variables see Tables S7-S8 in the Supplemental Material). In Table 1, there is no detectable influence from BMI. A later table, Table S3 in the Supplemental Material, however, is consistent with the existence of an inverse relationship between current BMI and future well-being.

Figure 1 uses coefficients from longitudinal estimates. Fixed-effect estimation is equivalent here to a first-difference estimator, as discussed in *28*, so they emerge, in effect, from regressing the change in well-being between 2007 and 2009 on the change over that period in variables such as food consumption, income, marital status, and so on. This is why, in Table 1, attributes such as gender and ethnicity are omitted; they are unchanging and thus have automatically been differenced out. Table 2 repeats the calculations for the alternative dependent variable of feeling happy. Results are similar.

An open scientific issue is whether diet might have slow-acting effects on mental well-being. The analyses reported in Table 3 explore this. They treat the data as if from a prospective setting. Here the regression equations reveal that fruit and vegetable consumption in the current year is predictive of higher well-being -- measured either as life satisfaction or as happiness -- in the future even after controlling for current well-being (as well as controlling for the list of covariates in the tables). Hence, in the life-satisfaction equation in Table 3, for example, where the dependent variable is life satisfaction measured in period t+1, a variable for fruit and vegetable consumption in period t is statistically significant at the 99.9% confidence level ($\beta = 0.03$, 95% CI = [0.01, 0.04], $p < .001$), while holding constant life satisfaction in period t, which itself enters, as would be expected, with a large positive coefficient. Similar results are found for happiness in Table 3. The Supplemental Material

provides the equation specifications.

Such prospective analysis is subject to a potential objection. It is that some form of correlation might run in both directions simultaneously. To check for this, a form of Granger causality test was done, and is given in the Supplemental Material. Tables S4 and S5 test whether fruit and vegetable consumption in the future can be predicted from the level of life satisfaction or happiness in the current period. In neither case is there evidence for such reverse-causality; the effect does not achieve statistical significance in either of the tables. In Table S4, in fact, the variable has the wrong point-estimate sign (β = -0.003, 95% CI = [-0.03, 0.02], $p > .250$).

We checked whether the findings can be reproduced on a new round of the panel data set, which was released, towards the end of our project, for the year of 2013. The paper's key results can be replicated; the findings are presented in supplemental tables S9-S11. It can be seen in the extra tables that the coefficients remain essentially identical to those presented in the main body of the paper.

We also did a test for whether fruits and vegetables should be separated into two independent variables – rather than combined into the number of daily F&V portions variable that has been traditional in research on physical health. The results (not reported) suggested that for happiness and life-satisfaction equations it was appropriate to combine them into a single F&V variable. The null hypothesis of an identical well-being gradient for fruit intake and vegetables intake could not be rejected.

Last, we made another effort, in addition to the Granger causality tests, to tackle the inevitably complex issue of causality. To do so we exploit a public campaign that was designed to encourage healthy eating in Australia. Scientifically, the advantage of such a campaign is that, from a researcher's point of view, an advertising campaign of this kind could be seen as an exogenous positive 'shock' to people's motivation to eat a greater number of portions of fruit and vegetables. Hence it offers the possibility of a form of natural experiment: as the campaign came in, with different timings in different states, it might be expected that it would shift people's consumption decisions at these particular points in time. Any consequences, for mental well-being and physical well-being, might then go on to be detectable.

Known as the "Go For 2&5 Campaign", this initiative began in the state of Western Australia in the year 2004. It spread, at different speeds, into most of the other Australian states. Two-stage least squares estimation can then be done (as described in reference *29*). The instrumental-variable estimates are provided in supplemental tables S12-S15.

In this form of inquiry, we exploit the fact that different Australian states had different

number of years over which they systematically promoted the consumption of fruit and vegetables. Victoria did so for zero years; New South Wales for 2 years; Tasmania for 4 years; South Australia for 4 years; Queensland for 5 years; the Northern Territories for 7 years; ACT for 7 years; and Western Australia for 10 years. Thus we create a variable for Intensity of Campaign. This adds up the length (i.e. number of years) that a state had previously had a campaign. All states in our analysis are thereby given an integer-valued entry, from 0 for Victoria to 10 for Western Australia, as a measure of the different intensities of the public fruit-and-vegetable campaign in the different states. In plainer English, the citizens of each region can be thought of as having a different level of 'publicly-sponsored push' to eat in a healthy way. That policy variable can be viewed as an extraneous influence upon later state levels of consumption of fruit and vegetables.

Analytically, we then take two steps. The first is to estimate a Consumption of Fruit+Veg equation (not a well-being equation) for the year 2013. We then test whether a variable for Campaign Intensity comes in positively in that equation. We find that it does, with a statistically significant coefficient. Hence there is evidence that the Australian healthy-eating campaign had an effect on fruit and vegetable intake. Then, in the second stage of our two-stage least-squares estimation, a set of instrumented well-being regression equations for the year 2013 are estimated. The purpose is to correct for simultaneity bias and the possibility of reverse causality. After doing so, an instrumented variable for fruit and vegetable consumption is found to enter positively in a well-being equation (as in Table S12). Hence there is some evidence that the Australian healthy-eating campaign may have improved people's levels of life satisfaction and happiness. Nevertheless, it is not possible statistically to be certain of that conclusion. As is often found in the statistical literature on two-stage least-squares estimation, the level of statistical power here is insufficient for us to obtain truly small standard errors in the second-stage equations. The paper's confidence levels do not exceed 75% when using this final form of statistical method.

DISCUSSION

This study is a longitudinal examination of the links between food and people's psychological well-being. It examines data on the lives of a nationally representative sample of approximately 12,000 individuals between 2007 and 2009, and is able to check, and replicate, its main findings for additional newly-released data over the period 2009 to 2013. Prospective analysis and Granger-causality tests are also done. By using information on the

Australian "Go for 2&5 Campaign" it also attempts to offer instrumental-variable estimation.

This study's findings are consistent with the idea that eating certain foods is a form of investment in future happiness. The implications of fruit and vegetable consumption are estimated to be substantial and to operate within the space of two years -- too quickly to be a reflection of the physical advantages of diet for outcomes such as cardiovascular disease documented by earlier researchers (*2*). Moreover, as shown in Table S6 of the Supplemental Material, the fruit-and-vegetables effect still operates if the regression equation includes an extra covariate for self-reported health.

In a sense, the paper offers a new possibility for future public-policy programs to encourage healthy eating – the possibility that citizens in western society could be given evidence that 'happiness' gains from healthy eating may show up much more quickly than any long-distant improvement to their physical health. If individuals weigh up the likely benefits of fruit and vegetables in their diet, and set that against any perceived costs, both pecuniary and non-pecuniary, of doing so, scientific evidence of extra gains from a healthy diet may help persuade people to raise their intake of fruit and vegetables.

Two main issues remain to be tackled. First, although at the end of this study we attempted to address the causality problem by using instrumental-variable methods, a huge randomized trial would lead to a natural form of scientific evidence. The well-being research literature is, however, far from such a point; a randomized trial would have its own inherent difficulties, because a double-blind procedure would not be feasible, so placebo effects would be hard to disentangle; and large-scale longitudinal studies, of the sort described in this study, would still be required as part of a body of persuasive evidence. Second, the channels from eating certain food types to subjective well-being remain to be properly understood. For example, (*18*, *30*) discuss a variety of intriguing possibilities. These include a potential influence from vitamin B12 upon the eventual production of human serotonin, as well as the idea of a role for folate deficiency (see also *31*). A further potential channel (*32*) is that microbiota may modulate brain chemistry. Lastly, it may be possible eventually to link the current research to a new literature on antioxidants that is suggestive of a connection between human optimism and carotenoid in the blood (*33*). Further connections between the biology and practical public-health policy of healthy eating (*34*) remain to be forged. These issues demand attention.

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Author Contributions

Author contributions: RM had the idea for the study; RM and AJO designed the research; RM led the study and wrote up the first results; AJO made suggestions for changes; RM and AJO analyzed the data; both authors revised the draft. AJO wishes to record that the main credit for this work is due to RM.

Declaration of Conflicting Interests

The authors declare no conflict of interest.

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Table 1. Life Satisfaction Equations: Fixed-effects Regression Models of Changes in Life Satisfaction on Changes in Fruit and Vegetable Consumption and Covariates. Longitudinal Survey Data on 12,000 Adults, HILDA Survey 2007 and 2009.

	Model 1 (no covariates)		Model 2 (partial set of covariates)		Model 3 (full set of covariates)	
Independent variable	β	*p*	β	*p*	β	*p*
Fruit and vegetable portions/day	0.03 [0.01, 0.04]	.002	0.03 [0.01, 0.04]	.003	0.02 [0.01, 0.04]	.010
Log of household income			0.02 [-0.03, 0.06]	.452	0.02 [-0.03, 0.06]	.476
Age			-0.01 [-0.05, 0.04]	.837	-0.01 [-0.06, 0.04]	.758
Age^2			0.01 [-0.04, 0.05]	.766	0.01 [-0.04, 0.06]	.720
Masters or doctorate			-0.31 [-0.86, 0.24]	.271	-0.32 [-0.87, 0.23]	.256
Bachelor or honors			-0.07 [-0.48, 0.35]	.755	-0.05 [-0.46, 0.36]	.812
Graduate diploma or certificate			-0.18 [-0.51, 0.16]	.304	-0.17 [-0.51, 0.17]	.315
Advanced diploma			-0.09 [-0.46, 0.27]	.618	-0.10 [-0.47, 0.27]	.609
Professional qualification			-0.01 [-0.30, 0.28]	.944	-0.02 [-0.31, 0.27]	.894
Year 12 high school			-0.21 [-0.41,-0.01]	.036	-0.20 [-0.40, 0.00]	.045
Full-time student			-0.01 [-0.15, 0.13]	.894	0.00 [-0.15, 0.14]	.965
Unemployed			-0.21 [-0.43, 0.01]	.058	-0.22 [-0.44, 0.00]	.050
Not in the labor force			-0.02 [-0.13, 0.09]	.695	-0.04 [-0.15, 0.07]	.508
Married			-0.01 [-0.18, 0.16]	.917	-0.01 [-0.18, 0.16]	.895
Separated			-0.57 [-0.89, -0.26]	.000	-0.58 [-0.89, -0.26]	.000
Divorced			-0.32 [-0.63, -0.01]	.042	-0.33 [-0.64, -0.02]	.036
Widowed			-0.45 [-0.99, 0.09]	.099	-0.46 [-1.00, 0.08]	.097
Long-term health condition			-0.14 [-0.22, -0.07]	.000	-0.14 [-0.22, -0.07]	.000
# children under the age of 4			-0.01 [-0.10, 0.08]	.838	-0.01 [-0.09, 0.08]	.881
# children aged 5-14			0.06 [-0.02, 0.14]	.121	0.06 [-0.01, 0.14]	.108
Drink alcohol 1 or 2 days/week					0.02 [-0.09, 0.14]	.697
Drink alcohol 2 or 3 days/week					-0.01 [-0.11, 0.09]	.889
Drink alcohol 3 or 4 days/week					-0.03 [-0.17, 0.10]	.619
Drink alcohol 5 or 6 days/week					-0.04 [-0.20, 0.12]	.638
Drink alcohol everyday					-0.14 [-0.34, 0.06]	.159
Non-smoker					0.04 [-0.09, 0.17]	.532
Never eat red meat					0.20 [-0.16, 0.55]	.273
Never eat fish					-0.09 [-0.20, 0.02]	.107
Eat breakfast regularly					0.11 [0.03, 0.18]	.004
Drink low fat or skinny milk					-0.04 [-0.12, 0.04]	.316
Avoid fatty foods					-0.05 [-0.12, 0.01]	.105
BMI					0.01 [0.00, 0.01]	.115
Exercise regularly					0.09 [0.03, 0.14]	.002
Constant	7.81 [7.74, 7.88]	.000	7.90 [6.80, 9.00]	.000	7.75 [6.65, 8.85]	.000
Overall R^2	.02		.03		.03	
Number of individuals	12,385		12,385		12,385	
Number of observations	20,127		20,127		20,127	

Note: Values in parentheses are 95% confidence intervals. Dependent variable is *Life Satisfaction* [range: 0-10]. HILDA Survey data: Australia. Further details of the data set are available in reference (*35*). With two waves of data, a fixed-effects estimator is equivalent to a first-difference estimator; see, for example, reference *28*.

Table 2. Happiness Equations: Fixed-effects Regression Models of Changes in 'Been a Happy Person' on Changes in Fruit and Vegetable Consumption and Covariates. Longitudinal Survey Data on 12,000 Adults, HILDA Survey 2007 and 2009.

	Model 1 (no covariates)		Model 2 (partial set of covariates)		Model 3 (full set of covariates)	
Independent variable	β	*p*	β	*p*	β	*p*
Fruit and vegetable portions/day	0.02 [0.01, 0.03]	.003	0.02 [0.01, 0.04]	.002	0.02 [0.003, 0.03]	.017
Log of household income			0.02 [-0.02, 0.05]	.369	0.02 [-0.02, 0.05]	.320
Constant	4.35 [4.30, 4.40]	.000	4.29 [3.40, 5.17]	.000	4.31 [3.42, 5.20]	.000
Other covariates included	No		Yes (a partial set)		Yes (a full set)	
Overall R^2	.02		.01		.03	
Number of individuals	12,360		12,360		12,360	
Number of observations	20,054		20,054		20,054	

Note: Values in parentheses are 95% confidence intervals. Dependent variable is *Been a Happy Person* [range: 1-6]. HILDA Survey data: Australia. 'Partial set' and 'Full set' are as defined in columns 2 and 3, respectively, of Table 1. The full estimation results (with a complete set of control variable coefficient estimates) are available in Table S1 in the Supplemental Material.

Table 3. Prospective Analyses of Life Satisfaction and Happiness on Lagged Fruit and Vegetable Consumption. HILDA Survey 2007 (period *t*) and 2009 (period *t+1*)

	Life satisfaction $_{t+1}$	Been a happy person $_{t+1}$
Independent variable	β	β
Fruit and vegetable portions/day $_{t}$	0.03 [0.01, 0.04]	0.02 [0.01, 0.03]
Life satisfaction $_{t}$	0.49 [0.47, 0.50]	
Been a happy person $_{t}$		0.45 [0.43, 0.47]
Log of household income $_{t}$	0.03 [0.00, 0.07]	0.03 [0.00, 0.05]
Constant	3.98 [3.55, 4.41]	2.36 [2.04, 2.68]
Full set of other covariates:	Yes	Yes
Adjusted R^2	.31	.26
Number of observations	7,742	7,694

Note: Values in parentheses are 95% confidence intervals. First dependent variable is *Life Satisfaction* [range: 0-10] in period t+1 (year 2009). Second dependent variable is *Been a Happy Person* [range: 1-6] in period t+1 (year 2009). Period *t* denotes the year 2007. The full estimation results (with a complete set of control variable coefficient estimates) are available in Tables S2 and S3 in the Supplemental Material. The table's title uses the term 'prospective' for simplicity; it would be possible to object to this on strict semantic grounds; we obtained the data after the Wave 2 information, on year 2009, had been collected.

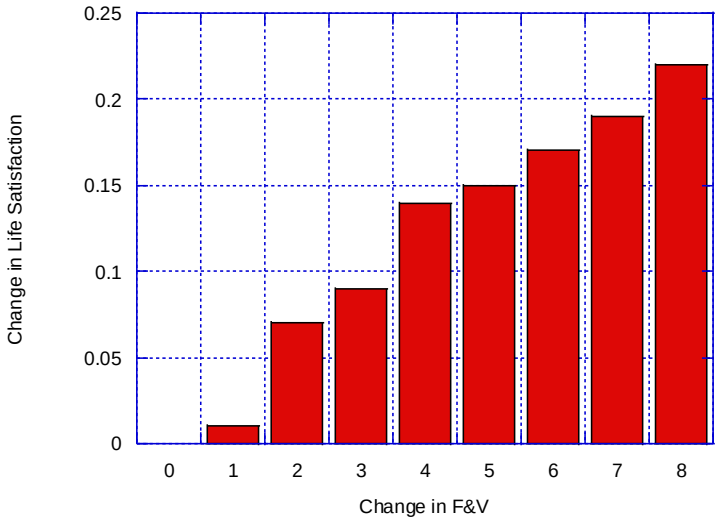

Fig. 1. Longitudinal changes in fruit and vegetable (F&V) consumption are positively correlated with longitudinal changes in satisfaction with life. The vertical axis here measures life satisfaction; the horizontal axis measures daily F&V portions. The 0 on the horizontal axis denotes less than one portion of fruit and vegetables per day, 1 denotes higher than one portion but less than two portions per day, .. and 8 denotes eight-and-above portions a day. The sample size is 12,385 Australian individuals measured in years 2007 and 2009.

An equivalent diagram would hold symmetrically for reductions in F&V consumption (not drawn above).

This figure is not cross-sectional. It is derived from a fixed-effects regression equation with nine banded dummy variables for the above nine different levels of fruit and vegetable (F&V) daily consumption. Formal test statistics are presented in Table 1, which treats F&V as a continuous variable.

END OF MANUSCRIPT……

SUPPLEMENTAL FILES: LATER MATERIAL IS FOR REFEREES ONLY AND/OR ONLINE PUBLICATION AS EXTRA INFORMATION FOR READERS.

Supplemental Files (For Referees or Online Publication Only)

Tables S1-S8
Figures S1-S4
Tables S9-S15

Table S1 (Full Estimation Results for Table 2). Happiness Equations: Fixed-effects Regression Models of Changes in 'Been a Happy Person' on Changes in Fruit and Vegetable Consumption and Covariates, HILDA Survey 2007 and 2009

	Model 1 (no covariates)		Model 2 (partial set of covariates)		Model 3 (full set of covariates)	
Independent variable	β	*p*	β	*p*	β	*p*
Fruit and vegetable portions/day	0.02 [0.01, 0.03]	.003	0.02 [0.01, 0.04]	.002	0.02 [0.003, 0.03]	.017
Log of household income			0.02 [-0.02, 0.05]	.369	0.02 [-0.02, 0.05]	.320
Age			-0.01 [-0.05, 0.03]	.736	0.00 [-0.04, 0.04]	.832
Age squared			0.01 [-0.03, 0.05]	.525	0.01 [-0.03, 0.05]	.571
Masters or doctorate			0.10 [-0.41, 0.61]	.697	0.15 [-0.35, 0.65]	.560
Bachelor or honors			-0.13 [-0.53, 0.26]	.507	-0.10 [-0.49, 0.29]	.614
Graduate diploma or certificate			-0.05 [-0.36, 0.27]	.778	-0.01 [-0.32, 0.30]	.942
Advanced diploma			-0.30 [-0.73, 0.13]	.173	-0.30 [-0.74, 0.15]	.190
Professional qualification			0.08 [-0.16, 0.32]	.493	0.08 [-0.16, 0.32]	.511
Year 12 high school			-0.04 [-0.23, 0.15]	.706	-0.01 [-0.20, 0.18]	.891
Full-time student			-0.03 [-0.16, 0.09]	.620	-0.03 [-0.15, 0.10]	.653
Unemployed			0.05 [-0.10, 0.19]	.528	0.05 [-0.10, 0.19]	.519
Not in the labor force			-0.10 [-0.19, -0.02]	.015	-0.11 [-0.19, -0.03]	.010
Married			-0.02 [-0.18, 0.14]	.808	-0.02 [-0.18, 0.14]	.805
Separated			-0.23 [-0.48, 0.03]	.083	-0.24 [-0.49, 0.02]	.069
Divorced			0.01 [-0.27, 0.29]	.942	-0.01 [-0.29, 0.27]	.958
Widowed			-0.14 [-0.47, 0.19]	.405	-0.15 [-0.48, 0.17]	.358
Long-term health condition			-0.07 [-0.13, -0.01]	.024	-0.06 [-0.12, 0.00]	.040
# children under the age of 4			0.03 [-0.03, 0.10]	.321	0.04 [-0.03, 0.11]	.233
# children aged 5-14			0.02 [-0.04, 0.08]	.460	0.03 [-0.03, 0.09]	.339
Drink alcohol 1 or 2 days/week					-0.05 [-0.14, 0.04]	.244
Drink alcohol 2 or 3 days/week					-0.02 [-0.10, 0.05]	.570
Drink alcohol 3 or 4 days/week					-0.07 [-0.17, 0.04]	.209
Drink alcohol 5 or 6 days/week					-0.04 [-0.16, 0.08]	.516
Drink alcohol everyday					0.03 [-0.12, 0.18]	.673
Non-smoker					0.01 [-0.09, 0.12]	.776
Never eat red meat					-0.02 [-0.27, 0.24]	.907
Never eat fish					0.05 [-0.04, 0.14]	.250
Eat breakfast regularly					0.12 [0.05, 0.18]	.000
Drink low fat or skinny milk					-0.01 [-0.07, 0.05]	.776
Avoid fatty foods					0.00 [-0.05, 0.05]	.935
BMI					-0.01 [-0.02, 0.00]	.009
Exercise regularly					0.14 [0.10, 0.19]	.000
Constant	4.35 [4.30, 4.40]	.000	4.29 [3.40, 5.17]	.000	4.31 [3.42, 5.20]	.000
Overall R^2	.02		.01		.03	
Number of individuals	12,360		12,360		12,360	
Number of observations	20,054		20,054		20,054	

Note: Values in parentheses are 95% confidence intervals. Dependent variable is *Been a Happy Person* [range: 1-6].

Table S2 (Full Estimation Results for First Part of Table 3). Prospective Analysis of Life Satisfaction: Linear Regression Model of Life Satisfaction on Lagged Fruit and Vegetable Consumption and Covariates, HILDA Survey 2007 (period *t*) and 2009 (period *t+1*)

Dependent variable: Life satisfaction $_{t+1}$			
Independent variable	β	*t*	*p*
Fruit and vegetable portions/day $_t$	0.03 [0.01, 0.04]	3.82	.000
Life satisfaction $_t$	0.48 [0.47, 0.50]	49.31	.000
Log of household income $_t$	0.03 [0.00, 0.07]	1.78	.075
Age $_t$	-0.02 [-0.03, -0.01]	3.16	.002
Age squared $_t$	0.02 [0.01, 0.03]	3.87	.000
Male $_t$	0.01 [-0.05, 0.06]	0.20	.845
Masters or doctorate $_t$	-0.13 [-0.27, 0.01]	1.77	.077
Bachelor or honors $_t$	-0.08 [-0.20, 0.04]	1.38	.169
Graduate diploma or certificate $_t$	-0.06 [-0.14, 0.03]	1.21	.225
Advanced diploma $_t$	-0.12 [-0.21, -0.02]	2.36	.018
Professional qualification $_t$	-0.06 [-0.13, 0.02]	1.47	.142
Year 12 high school $_t$	-0.08 [-0.16, 0.00]	1.86	.063
Full-time student $_t$	0.12 [-0.01, 0.25]	1.75	.080
Unemployed $_t$	0.03 [-0.15, 0.21]	0.32	.749
Not in the labor force $_t$	-0.03 [-0.11, 0.05]	0.83	.409
Married $_t$	0.13 [0.05, 0.21]	3.11	.002
Separated $_t$	-0.11 [-0.27, 0.05]	1.36	.175
Divorced $_t$	-0.01 [-0.12, 0.10]	0.15	.881
Widowed $_t$	0.26 [0.10, 0.41]	3.22	.001
Long-term health condition $_t$	-0.21 [-0.28, -0.15]	6.28	.000
# children under the age of 4 $_t$	0.01 [-0.05, 0.07]	0.34	.732
# children aged 5-14 $_t$	-0.03 [-0.07, 0.01]	1.65	.099
Drink alcohol 1 or 2 days/ week $_t$	0.02 [-0.06, 0.09]	0.43	.665
Drink alcohol 2 or 3 days/ week $_t$	0.06 [-0.03, 0.14]	1.29	.196
Drink alcohol 3 or 4 days/ week $_t$	0.04 [-0.04, 0.12]	0.96	.336
Drink alcohol 5 or 6 days/ week $_t$	0.03 [-0.07, 0.13]	0.63	.529
Drink alcohol everyday $_t$	0.04 [-0.06, 0.14]	0.76	.448
Non-smoker $_t$	0.08 [0.01, 0.15]	2.19	.029
Never eat red meat $_t$	-0.13 [-0.28, 0.03]	1.54	.123
Never eat fish $_t$	0.02 [-0.07, 0.11]	0.43	.665
Eat breakfast regularly $_t$	0.03 [-0.04, 0.09]	0.85	.397
Drink low fat or skinny milk $_t$	0.05 [-0.01, 0.10]	1.75	.080
Avoid fatty foods $_t$	0.05 [-0.01, 0.11]	1.65	.098
BMI $_t$	-0.01 [-0.01, 0.00]	2.79	.005
Exercise regularly $_t$	0.06 [0.01, 0.11]	2.29	.022
Constant	3.98 [3.55, 4.41]	18.34	.000
Adjusted R^2	.31		
Number of observations	7,742		

Note: Values in parentheses are 95% confidence intervals. Dependent variable is *Life Satisfaction* [range: 0-10] in period t+1 (year 2009).

524 **Table S3 (Full Estimation Results for Second Part of Table 3).** Prospective Analysis of Happiness: Linear
525 Regression Model of 'Been a Happy Person' on Lagged Fruit and Vegetable Consumption and Covariates,
526 HILDA Survey 2007 (period *t*) and 2009 (period *t+1*)
527

Dependent variable: Been a happy person $_{t+1}$			
Independent variable	β	*t*	*p*
Fruit and vegetable portions/day $_t$	0.02 [0.01, 0.03]	3.97	.000
Been a happy person $_t$	0.45 [0.43, 0.47]	44.26	.000
Log of household income $_t$	0.03 [0.00, 0.05]	1.84	.066
Age $_t$	-0.01 [-0.02, 0.00]	2.93	.003
Age squared $_t$	0.01 [0.00, 0.02]	2.87	.004
Male $_t$	0.01 [-0.04, 0.05]	0.23	.822
Masters or doctorate $_t$	-0.01 [-0.12, 0.10]	0.21	.833
Bachelor or honors $_t$	-0.03 [-0.13, 0.06]	0.65	.514
Graduate diploma or certificate $_t$	-0.02 [-0.09, 0.05]	0.57	.569
Advanced diploma $_t$	0.00 [-0.08, 0.07]	0.08	.936
Professional qualification $_t$	-0.04 [-0.10, 0.02]	1.35	.176
Year 12 high school $_t$	-0.02 [-0.09, 0.05]	0.58	.560
Full-time student $_t$	-0.02 [-0.12, 0.08]	0.32	.745
Unemployed $_t$	-0.21 [-0.35, -0.07]	2.87	.004
Not in the labor force $_t$	-0.02 [-0.08, 0.04]	0.56	.572
Married $_t$	0.10 [0.03, 0.16]	2.87	.004
Separated $_t$	0.09 [-0.03, 0.22]	1.41	.157
Divorced $_t$	0.09 [0.00, 0.18]	1.96	.050
Widowed $_t$	0.31 [0.19, 0.43]	4.97	.000
Long-term health condition $_t$	-0.24 [-0.29, -0.19]	8.96	.000
# children under the age of 4 $_t$	-0.03 [-0.08, 0.01]	1.39	.165
# children aged 5-14 $_t$	-0.03 [-0.06, 0.00]	1.93	.054
Drink alcohol 1 or 2 days/ week $_t$	0.11 [0.05, 0.17]	3.71	.000
Drink alcohol 2 or 3 days/ week $_t$	0.04 [-0.02, 0.11]	1.27	.206
Drink alcohol 3 or 4 days/ week $_t$	0.06 [0.00, 0.12]	1.83	.067
Drink alcohol 5 or 6 days/ week $_t$	0.13 [0.05, 0.20]	3.25	.001
Drink alcohol everyday $_t$	0.03 [-0.05, 0.11]	0.72	.473
Non-smoker $_t$	0.03 [-0.02, 0.09]	1.23	.217
Never eat red meat $_t$	-0.01 [-0.13, 0.12]	0.13	.899
Never eat fish $_t$	-0.03 [-0.10, 0.04]	0.77	.441
Eat breakfast regularly $_t$	0.02 [-0.03, 0.07]	0.65	.516
Drink low fat or skinny milk $_t$	-0.01 [-0.05, 0.03]	0.52	.604
Avoid fatty foods $_t$	0.03 [-0.02, 0.08]	1.08	.279
BMI $_t$	0.00 [-0.01, 0.00]	1.78	.074
Exercise regularly $_t$	0.06 [0.01, 0.10]	2.66	.008
Constant	2.36 [2.04, 2.68]	14.40	.000
Adjusted R^2	.26		
Number of observations	7,694		

528 Note: Values in parentheses are 95% confidence intervals. Dependent variable is *Been a Happy Person* [range: 1-6] in period t+1 (year
529 2009).
530

Table S4. Granger Causality Test: Linear Regression Model of Fruit and Vegetable Consumption on Lagged Life Satisfaction and Covariates, HILDA Survey 2007 (period *t*) and 2009 (period *t+1*)

Dependent variable: Fruit and vegetable consumption $_{t+1}$			
Independent variable	β	*t*	*p*
Life satisfaction $_{t}$	-0.003 [-0.03, 0.02]	0.22	.827
Fruit and vegetable portions/day $_{t}$	0.55 [0.53, 0.57]	57.23	.000
Log of household income $_{t}$	0.01 [-0.04, 0.06]	0.33	.739
Age $_{t}$	0.02 [0.01, 0.04]	3.11	.002
Age squared $_{t}$	-0.01 [-0.03, 0.00]	1.37	.170
Male $_{t}$	-0.16 [-0.24, -0.09]	4.16	.000
Masters or doctorate $_{t}$	0.20 [0.01, 0.39]	2.07	.038
Bachelor or honors $_{t}$	0.29 [0.13, 0.46]	3.54	.000
Graduate diploma or certificate $_{t}$	0.19 [0.07, 0.31]	3.02	.003
Advanced diploma $_{t}$	0.19 [0.06, 0.32]	2.79	.005
Professional qualification $_{t}$	0.15 [0.05, 0.25]	2.87	.004
Year 12 high school $_{t}$	0.12 [0.00, 0.23]	2.02	.043
Full-time student $_{t}$	0.27 [0.10, 0.45]	3.06	.002
Unemployed $_{t}$	0.01 [-0.23, 0.26]	0.08	.934
Not in the labor force $_{t}$	-0.03 [-0.13, 0.08]	0.54	.591
Married $_{t}$	0.04 [-0.07, 0.15]	0.67	.500
Separated $_{t}$	-0.18 [-0.40, 0.04]	1.61	.107
Divorced $_{t}$	-0.10 [-0.25, 0.06]	1.24	.216
Widowed $_{t}$	-0.12 [-0.33, 0.09]	1.13	.259
Long-term health condition $_{t}$	0.02 [-0.07, 0.11]	0.52	.605
# children under the age of 4 $_{t}$	-0.04 [-0.11, 0.04]	0.92	.360
# children aged 5-14 $_{t}$	-0.02 [-0.07, 0.04]	0.61	.541
Drink alcohol 1 or 2 days/week $_{t}$	-0.02 [-0.12, 0.09]	0.29	.769
Drink alcohol 2 or 3 days/week $_{t}$	-0.02 [-0.14, 0.10]	0.29	.772
Drink alcohol 3 or 4 days/week $_{t}$	0.01 [-0.10, 0.12]	0.25	.806
Drink alcohol 5 or 6 days/week $_{t}$	0.05 [-0.08, 0.18]	0.70	.484
Drink alcohol everyday $_{t}$	0.03 [-0.11, 0.17]	0.42	.678
Non-smoker $_{t}$	0.25 [0.16, 0.35]	5.20	.000
Never eat red meat $_{t}$	0.09 [-0.13, 0.30]	0.81	.419
Never eat fish $_{t}$	-0.19 [-0.31, -0.07]	3.10	.002
Eat breakfast regularly $_{t}$	0.19 [0.10, 0.27]	4.31	.000
Drink low fat or skinny milk $_{t}$	0.01 [-0.06, 0.08]	0.31	.758
Avoid fatty foods $_{t}$	0.15 [0.06, 0.23]	3.48	.001
BMI $_{t}$	0.00 [-0.01, 0.01]	0.06	.951
Exercise regularly $_{t}$	0.21 [0.13, 0.28]	5.63	.000
Constant	0.40 [-0.18, 0.97]	1.35	.177
Adjusted R^2	.42		
Number of observations	7,742		

Note: Values in parentheses are 95% confidence intervals. Dependent variable is *Fruit and Vegetable Consumption* (portions per day) in period t+1 (year 2009). It should be noted that Granger causality examines how an outcome variable of interest is correlated with lagged values of the same variable (from previous periods) as well as lagged values of other explanatory variables. This method is analogous to prospective analysis, but is not equivalent to identifying the true causal effect of one variable on another (where, for example, a change in the variable *X* strictly leads to a change in the variable *Y*).

Table S5. Granger Causality Test: Linear Regression Model of Fruit and Vegetable Consumption on Lagged 'Been a Happy Person' and Covariates, HILDA Survey 2007 (period *t*) and 2009 (period *t+1*)

Dependent variable: Fruit and vegetable consumption $_{t+1}$			
Independent variable	β	*t*	*p*
Been a happy person $_t$	0.03 [-0.01, 0.06]	1.63	.104
Fruit and vegetable portions/day $_t$	0.55 [0.53, 0.57]	56.72	.000
Log of household income $_t$	0.01 [-0.04, 0.05]	0.22	.826
Age $_t$	0.02 [0.01, 0.04]	3.29	.001
Age squared $_t$	-0.01 [-0.03, 0.00]	1.61	.108
Male $_t$	-0.17 [-0.24, -0.09]	4.20	.000
Masters or doctorate $_t$	0.21 [0.02, 0.40]	2.17	.030
Bachelor or honors $_t$	0.30 [0.14, 0.47]	3.66	.000
Graduate diploma or certificate $_t$	0.20 [0.08, 0.32]	3.18	.001
Advanced diploma $_t$	0.19 [0.06, 0.32]	2.81	.005
Professional qualification $_t$	0.16 [0.05, 0.26]	2.99	.003
Year 12 high school $_t$	0.12 [0.01, 0.24]	2.07	.039
Full-time student $_t$	0.27 [0.10, 0.45]	3.06	.002
Unemployed $_t$	0.03 [-0.22, 0.27]	0.23	.822
Not in the labor force $_t$	-0.02 [-0.13, 0.08]	0.46	.644
Married $_t$	0.05 [-0.06, 0.16]	0.88	.379
Separated $_t$	-0.17 [-0.39, 0.05]	1.53	.126
Divorced $_t$	-0.09 [-0.24, 0.06]	1.17	.242
Widowed $_t$	-0.10 [-0.31, 0.11]	0.95	.344
Long-term health condition $_t$	0.04 [-0.05, 0.14]	0.97	.333
# children under the age of 4 $_t$	-0.04 [-0.12, 0.04]	0.98	.325
# children aged 5-14 $_t$	-0.02 [-0.07, 0.04]	0.62	.534
Drink alcohol 1 or 2 days/ week $_t$	-0.01 [-0.12, 0.09]	0.27	.787
Drink alcohol 2 or 3 days/week $_t$	-0.01 [-0.13, 0.11]	0.21	.831
Drink alcohol 3 or 4 days/ week $_t$	0.01 [-0.10, 0.12]	0.19	.849
Drink alcohol 5 or 6 days/ week $_t$	0.04 [-0.09, 0.17]	0.62	.533
Drink alcohol everyday $_t$	0.02 [-0.11, 0.16]	0.33	.740
Non-smoker $_t$	0.24 [0.15, 0.34]	4.97	.000
Never eat red meat $_t$	0.10 [-0.12, 0.31]	0.87	.386
Never eat fish $_t$	-0.20 [-0.32, -0.08]	3.27	.001
Eat breakfast regularly $_t$	0.18 [0.10, 0.27]	4.19	.000
Drink low fat or skinny milk $_t$	0.01 [-0.06, 0.08]	0.25	.801
Avoid fatty foods $_t$	0.15 [0.07, 0.23]	3.49	.000
BMI $_t$	0.00 [-0.01, 0.01]	0.05	.957
Exercise regularly $_t$	0.20 [0.13, 0.28]	5.50	.000
Constant	0.27 [-0.29, 0.82]	0.93	.350
Adjusted R^2	.42		
Number of observations	7,694		

Note: Values in parentheses are 95% confidence intervals. Dependent variable is *Fruit and Vegetable Consumption* (portions per day) in period t+1 (year 2009). It should be noted that Granger causality examines how an outcome variable of interest is correlated with lagged values of the same variable (from previous periods) as well as lagged values of other explanatory variables. This method is analogous to prospective analysis, but is not equivalent to identifying the true causal effect of one variable on another (where, for example, a change in the variable *X* strictly leads to a change in the variable *Y*).

Table S6. **Life Satisfaction Equation Robustness Test: Fixed-effects Regression Model of Changes in Life Satisfaction on Changes in Fruit and Vegetable Consumption and Covariates (including Self-reported Health)**, HILDA Survey 2007 and 2009

Dependent variable: Life Satisfaction			
Independent variable	β	*t*	*p*
Fruit and vegetable portions/day	0.02 [0.01, 0.03]	1.99	.047
Self-reported health	0.29 [0.25, 0.34]	12.22	.000
Log of household income	0.02 [-0.03, 0.06]	0.72	.468
Age	-0.03 [-0.07, 0.02]	-1.01	.314
Age squared	0.02 [-0.02, 0.07]	1.00	.318
Masters or doctorate	-0.22 [-0.78, 0.33]	-0.79	.428
Bachelor or honors	0.10 [-0.32, 0.52]	0.49	.627
Graduate diploma or certificate	-0.05 [-0.39, 0.29]	-0.29	.770
Advanced diploma	-0.01 [-0.40, 0.37]	-0.08	.939
Professional qualification	0.02 [-0.26, 0.30]	0.13	.896
Year 12 high school	-0.12 [-0.31, 0.08]	-1.19	.236
Full-time student	-0.01 [-0.16, 0.13]	-0.16	.872
Unemployed	-0.24 [-0.46, -0.02]	-2.11	.035
Not in the labor force	-0.03 [-0.14, 0.08]	-0.48	.632
Married	0.01 [-0.16, 0.17]	0.09	.930
Separated	-0.55 [-0.86, -0.23	-3.40	.001
Divorced	-0.35 [-0.66, -0.04]	-2.22	.026
Widowed	-0.54 [-1.09, 0.02]	-1.88	.060
Long-term health condition	-0.09 [-0.16, -0.02]	-2.38	.017
# children under the age of 4	0.01 [-0.08, 0.09]	0.13	.895
# children aged 5-14	0.07 [-0.01, 0.15]	1.61	.107
Drink alcohol 1 or 2 days/week	0.00 [-0.12, 0.11]	-0.06	.953
Drink alcohol 2 or 3 days/week	-0.01 [-0.11, 0.08]	-0.26	.794
Drink alcohol 3 or 4 days/week	-0.05 [-0.18, 0.09]	-0.67	.500
Drink alcohol 5 or 6 days/week	-0.06 [-0.22, 0.10]	-0.76	.450
Drink alcohol everyday	-0.17 [-0.37, 0.03]	-1.67	.095
Non-smoker	0.04 [-0.09, 0.16]	0.61	.541
Never eat red meat	0.17 [-0.18, 0.52]	0.94	.346
Never eat fish	-0.08 [-0.18, 0.03]	-1.37	.171
Eat breakfast regularly	0.10 [0.02, 0.17]	2.54	.011
Drink low fat or skinny milk	-0.04 [-0.11, 0.04]	-0.97	.332
Avoid fatty foods	-0.05 [-0.12, 0.01]	-1.54	.124
BMI	0.01 [0.00, 0.02]	2.12	.034
Exercise regularly	0.05 [-0.01, 0.10]	1.72	.086
Constant	7.09 [5.99, 8.20]	12.57	.000
Overall R^2	.09		
Number of individuals	12,288		
Number of observations	19,778		

Note: Values in parentheses are 95% confidence intervals. Dependent variable is *Life Satisfaction* [range: 0-10]. For the self-reported health measure (covariate), individuals in the HILDA Survey were asked: "*In general, would you say your health is: Excellent, Very Good, Good, Fair, or Poor*". The resulting response distribution was as follows: 3% (Poor); 12.8% (Fair); 35.2% (Good); 36.8% (Very Good); 12.1% (Excellent). In the analysis above, these individual responses are coded from 1 (Poor) to 5 (Excellent), with the average reported score being 3.42 out of 5.

Table S7. Description of Demographic and Socioeconomic Covariates

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 honors	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 labor 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 aged 5-14	0.31	0.71	0	6

Table S8. Description of Dietary and Lifestyle Covariates

Variable	Description	Mean	SD	Min	Max
Daily fruit intake	Average number of fruit serves based on weekly intake	1.42	1.15	0	≥5
Daily vegetable intake	Average number of vegetable serves based on weekly intake	2.43	1.34	0	≥5
Weekly fruit intake frequency	Number of days in a usual week that fruit is eaten	5.31	2.17	0	7
Weekly vegetable intake frequency	Number of days in a usual week that vegetables are eaten	5.75	1.55	0	7
Usual fruit intake quantity	On those days, number of fruit serves eaten	1.79	1.07	0	≥5
Usual vegetable intake quantity	On those days, number of vegetable serves eaten	2.89	1.28	0	≥5
Alcohol intake 1	Drink alcohol: never, no longer, or rarely	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
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
Regular physical exercise	Exercise at least three times a week per week; moderately to intensively	0.51	0.50	0	1
BMI	Body Mass Index	26.59	5.66	9.6	85.3

Note: Average *Daily fruit intake* = (*Weekly fruit intake frequency* × *Usual fruit intake quantity*) divided by 7 days. Similarly, average *Daily vegetable intake* = (*Weekly vegetable intake frequency* × *Usual vegetable intake quantity*) divided by 7 days. The *Weekly intake frequency* and *Usual intake quantity* variables correspond to the fruit and vegetable intake 'frequency' and 'quantity' survey questions presented in the Methods section. A standard serve (or portion) of fruit is 150 grams. A standard serve of vegetables is 75 grams.

Supplemental Figures:

These are derived from change-on-change regression equations.

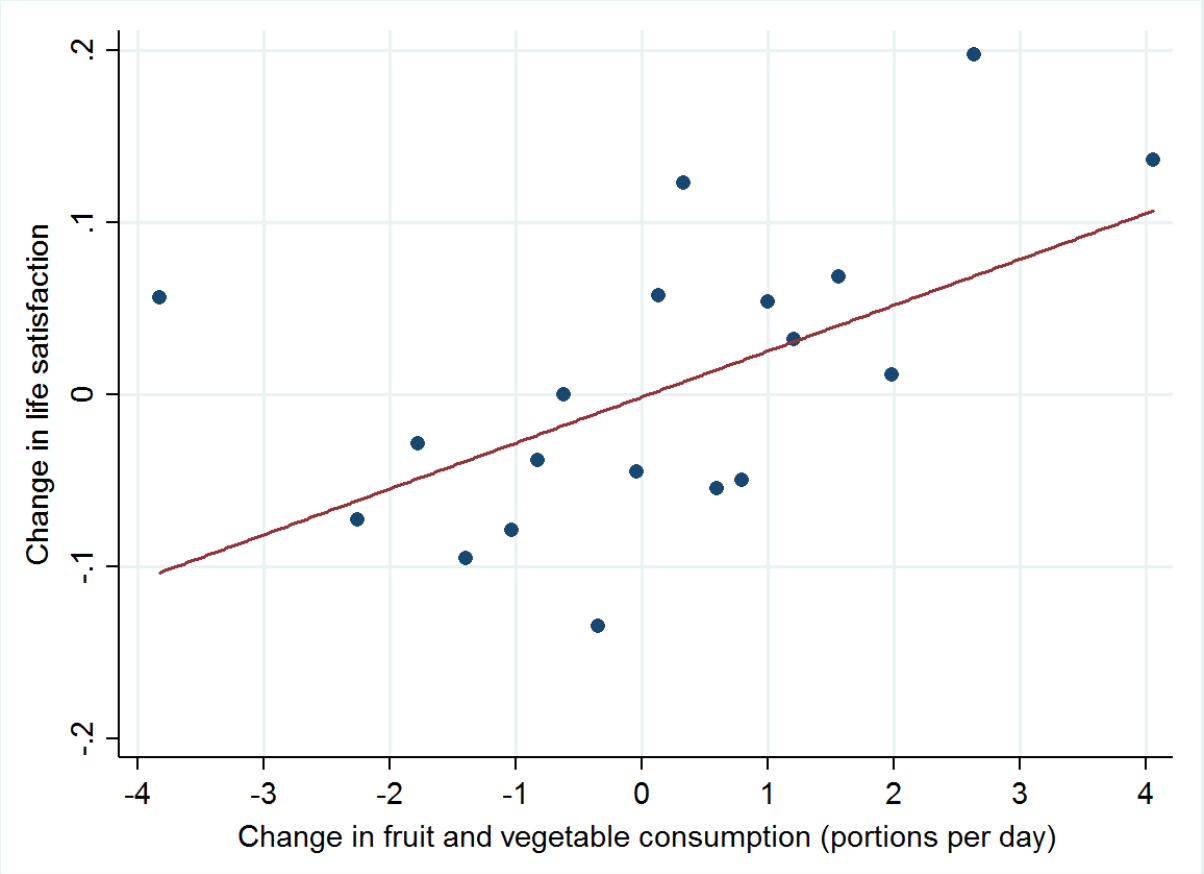

Fig. S1. Scatter plot of change in fruit-and-vegetable consumption and change in satisfaction with life. To derive this scatter plot, we generate fractional changes (such as -0.3 change in fruit and vegetable consumption) in portions consumed between the two periods due to the fruit-and-vegetable intake variable being the average daily amount of fruit and vegetables consumed (derived from the total weekly amount - this is how the questions in the HILDA Survey are asked). Hence, the F+V variable (and its changes between the two periods) does not take on a whole number (portion) for some individuals due to the averaging performed to get from the weekly to average daily amounts. To get rid of the ensuing tens of thousands data points, we used the Stata command (called 'binscatter') that bands the points and produces a line of best fit.

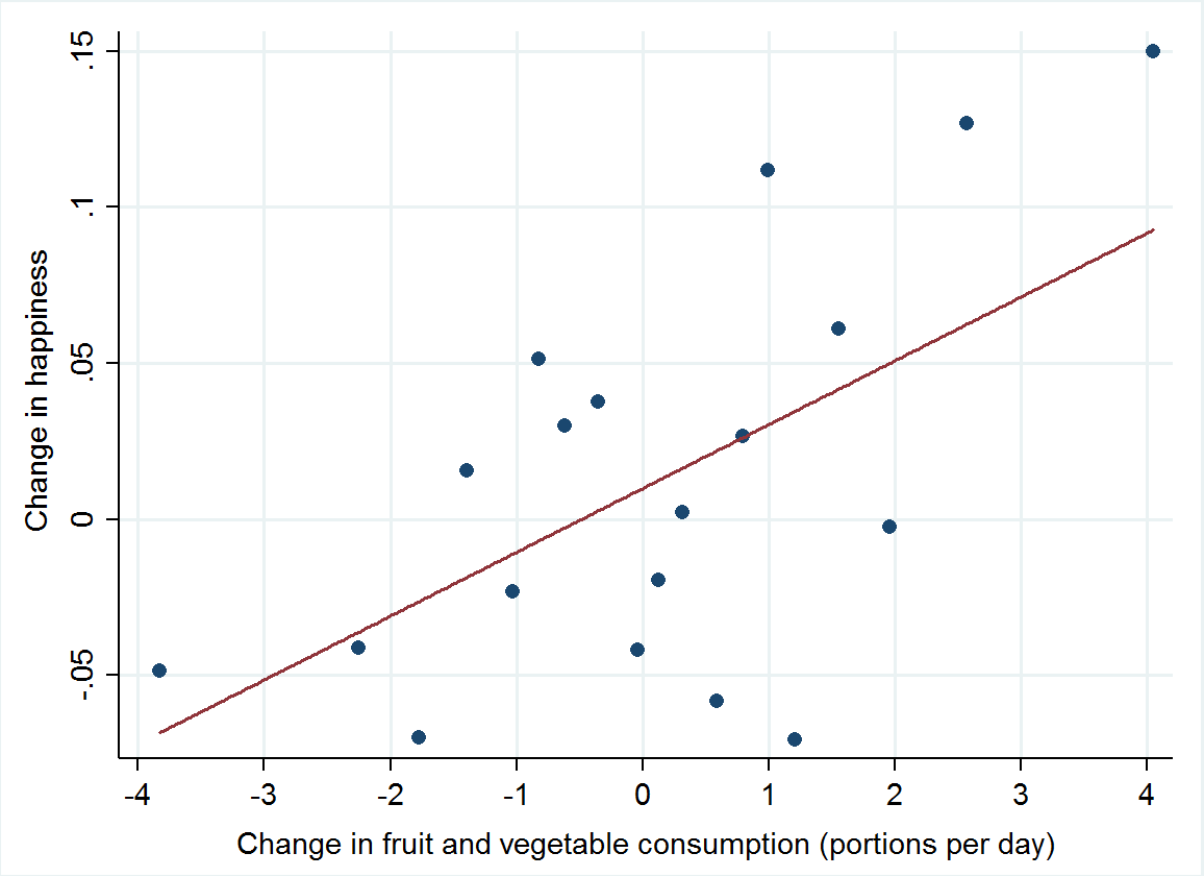

Fig. S2. Scatter plot of change in fruit-and-vegetable consumption and change in happiness. To derive this scatter plot, we generate fractional changes (such as -0.3 change in fruit and vegetable consumption) in portions consumed between the two periods due to the fruit-and-vegetable intake variable being the average daily amount of fruit and vegetables consumed (derived from the total weekly amount - this is how the questions in the HILDA Survey are asked). Hence, the F+V variable (and its changes between the two periods) does not take on a whole number (portion) for some individuals due to the averaging performed to get from the weekly to average daily amounts. To get rid of the ensuing tens of thousands data points, we used the Stata command (called 'binscatter') that bands the points and produces a line of best fit.

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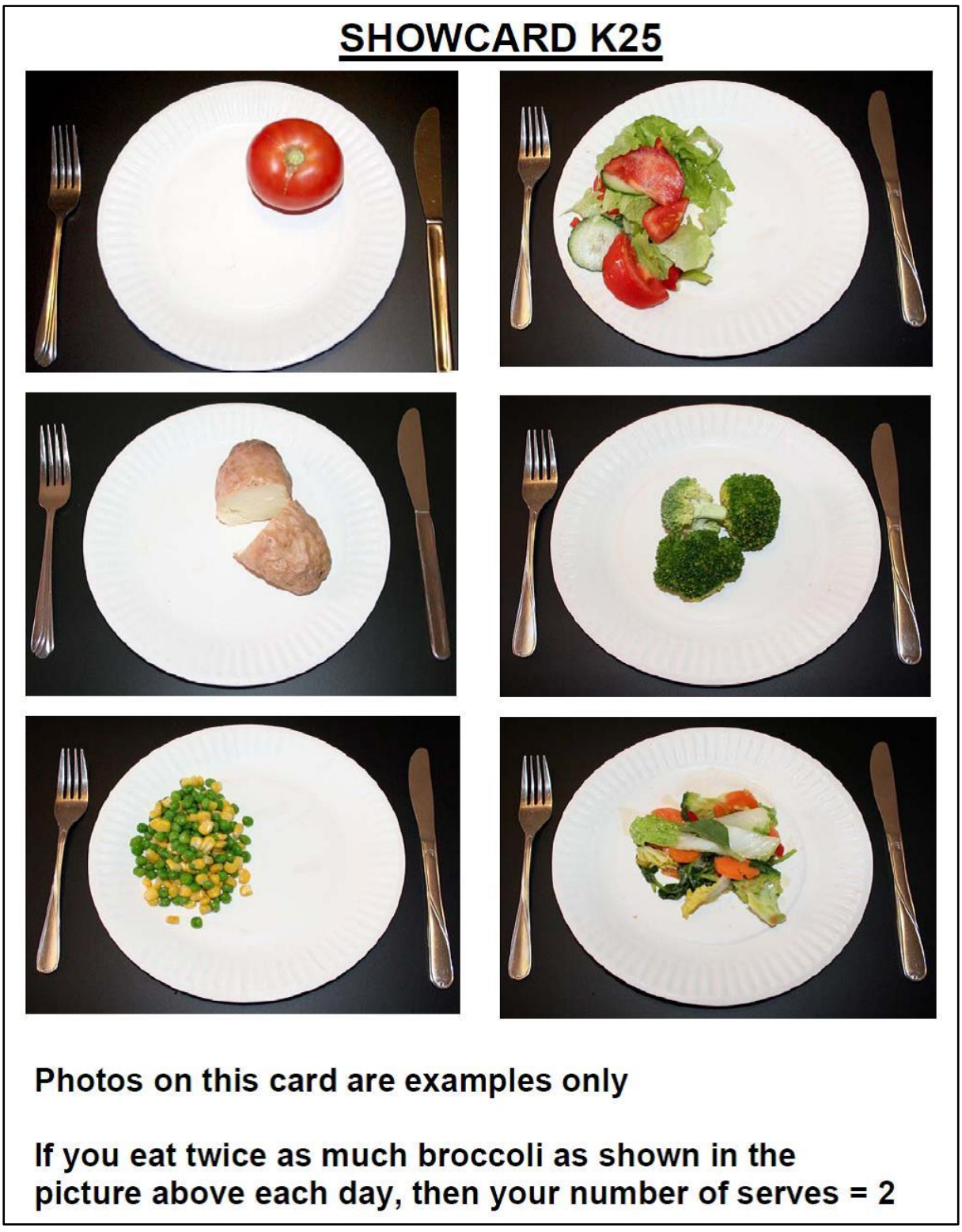

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599 **Fig. S3.** Vegetable servings size (Showcard K25, HILDA Survey, Waves 7 and 9)

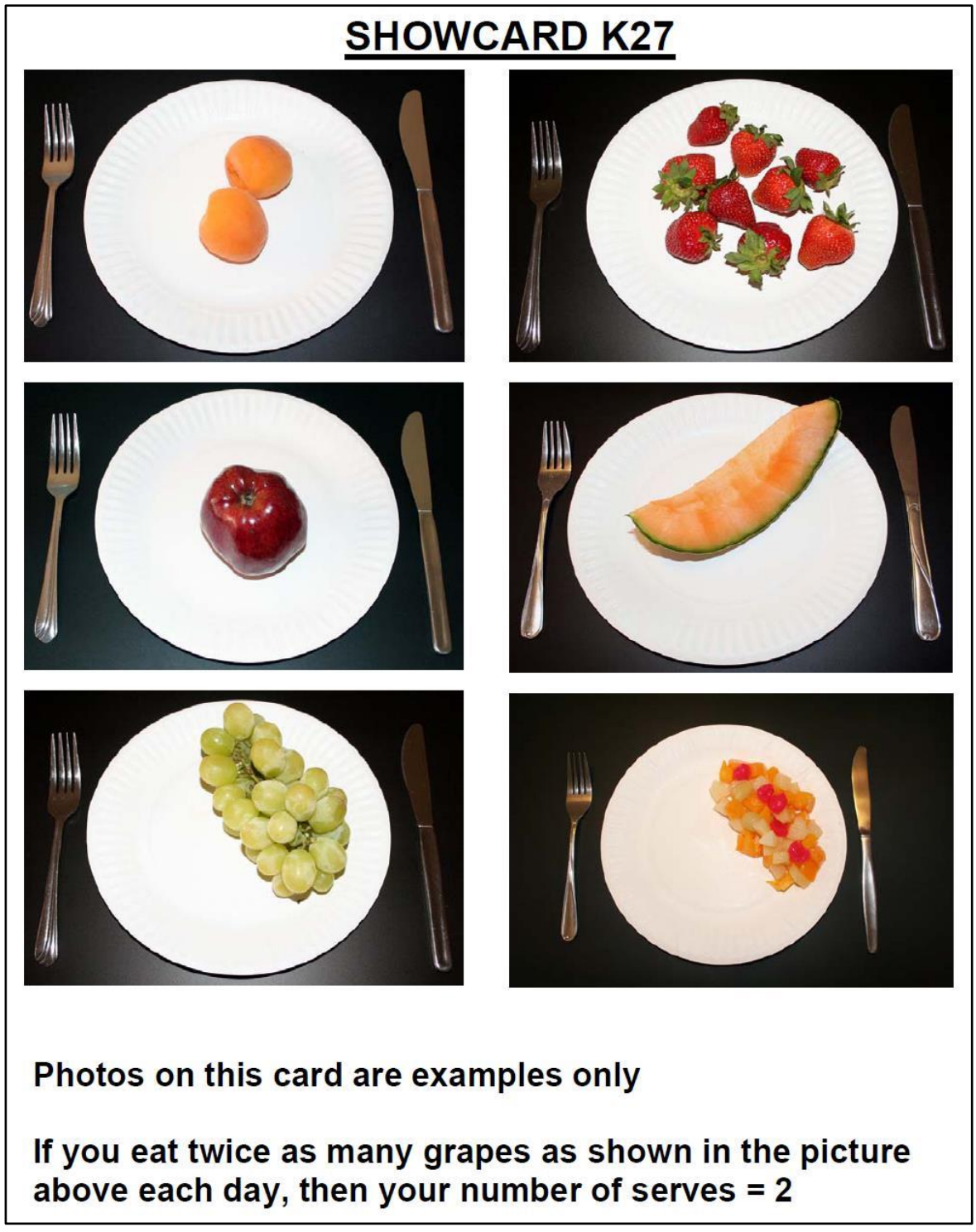

Fig. S4. Fruit servings size (Showcard K27, HILDA Survey, Waves 7 and 9)

Further Supplemental Appendix: The Results Re-Estimated On New Data From 2009-2013, and Instrumental-Variable Estimation.

Table S9. (Table 1 Redone on Further Data). Life Satisfaction Equations: Fixed-effects Regression Models of Changes in Life Satisfaction on Changes in Fruit and Vegetable Consumption and Covariates, HILDA Survey 2009 and 2013

	Model 1 (no covariates)		Model 2 (partial set of covariates)		Model 3 (full set of covariates)	
Independent variable	β	*p*	β	*p*	β	*p*
Fruit and vegetable portions/day	0.04 [0.02, 0.06]	.000	0.04 [0.03, 0.06]	.000	0.04 [0.02, 0.05]	.000
Log of household income			0.01 [-0.03, 0.05]	.682	0.01 [-0.03, 0.05]	.596
Age			-0.02 [-0.05, 0.00]	.082	-0.03 [-0.05, 0.00]	.050
Age^2			0.02 [-0.01, 0.04]	.165	0.02 [0.00, 0.05]	.108
Masters or doctorate			0.04 [-0.30, 0.38]	.810	0.04 [-0.30, 0.38]	.816
Bachelor or honors			-0.14 [-0.49, 0.22]	.444	-0.15 [-0.50, 0.20]	.411
Graduate diploma or certificate			-0.06 [-0.31, 0.19]	.647	-0.06 [-0.31, 0.19]	.643
Advanced diploma			0.10 [-0.14, 0.35]	.421	0.11 [-0.13, 0.35]	.372
Professional qualification			-0.13 [-0.34, 0.08]	.237	-0.12 [-0.33, 0.09]	.254
Year 12 high school			-0.09 [-0.26, 0.07]	.268	-0.07 [-0.24, 0.09]	.396
Full-time student			0.01 [-0.12, 0.14]	.876	0.01 [-0.12, 0.14]	.836
Unemployed			-0.22 [-0.40, -0.04]	.018	-0.22 [-0.40, -0.05]	.014
Not in the labor force			-0.05 [-0.13, 0.04]	.318	-0.05 [-0.14, 0.04]	.276
Married			0.05 [-0.09, 0.19]	.452	0.04 [-0.10, 0.18]	.568
Separated			-0.48 [-0.74, -0.23]	.000	-0.51 [-0.76, -0.26]	.000
Divorced			0.14 [-0.12, 0.40]	.293	0.12 [-0.14, 0.38]	.359
Widowed			0.04 [-0.26, 0.33]	.808	0.02 [-0.27, 0.32]	.875
Long-term health condition			-0.22 [-0.30, -0.15]	.000	-0.22 [-0.30, -0.15]	.000
# children under the age of 4			-0.08 [-0.14, -0.02]	.008	-0.07 [-0.13, -0.02]	.013
# children aged 5-14			-0.04 [-0.09, 0.01]	.142	-0.04 [-0.09, 0.01]	.138
Drink alcohol 1 or 2 days/week					-0.05 [-0.14, 0.05]	.321
Drink alcohol 2 or 3 days/week					-0.03 [-0.12, 0.07]	.579
Drink alcohol 3 or 4 days/week					-0.04 [-0.16, 0.07]	.478
Drink alcohol 5 or 6 days/week					-0.12 [-0.26, 0.02]	.097
Drink alcohol everyday					-0.11 [-0.27, 0.05]	.190
Non-smoker					0.03 [-0.08, 0.14]	.639
Never eat red meat					0.03 [-0.25, 0.32]	.829
Never eat fish					-0.08 [-0.19, 0.02]	.130
Eat breakfast regularly					0.13 [0.06, 0.20]	.001
Drink low fat or skinny milk					0.03 [-0.03, 0.09]	.332
Avoid fatty foods					0.01 [-0.05, 0.07]	.817
BMI					0.00 [-0.01, 0.01]	.773
Exercise regularly					0.15 [0.09, 0.20]	.000
Constant	7.76 [7.70, 7.83]	.000	8.41 [7.79, 9.04]	.000	8.38 [7.72, 9.04]	.000
Overall R^2	.02		.03		.04	
Number of individuals	16,242		16,242		16,242	
Number of observations	23,985		23,985		23,985	

Note: Values in parentheses are 95% confidence intervals. Dependent variable is *Life Satisfaction* [range: 0-10].

Table S10. (Table 2 Redone on Further Data) Happiness Equations: Fixed-effects Regression Models of Changes in 'Been a Happy Person' on Changes in Fruit and Vegetable Consumption and Covariates, HILDA Survey Data 2009 and 2013

	Model 1 (no covariates)		Model 2 (partial set of covariates)		Model 3 (full set of covariates)	
Independent variable	β	*p*	β	*p*	β	*p*
Fruit and vegetable portions/day	0.02 [0.01, 0.04]	.000	0.02 [0.01, 0.04]	.001	0.02 [0.01, 0.03]	.006
Log of household income			-0.01 [-0.03, 0.03]	.790	-0.01 [-0.03, 0.03]	.823
Other covariates included	No		Partial		Full	
Constant	4.33 [4.28, 4.38]	.000	5.04 [4.53, 5.56]	.000	5.06 [4.51, 5.60]	.000
Overall R^2	.01		.01		.02	
Number of individuals	16,206		16,206		16,206	
Number of observations	23,917		23,917		23,917	

Note: Values in parentheses are 95% confidence intervals. Dependent variable is *Been a Happy Person* [range: 1-6].

Table S11. (Full Version of Table S10). Happiness Equations: Fixed-effects Regression Models of Changes in 'Been a Happy Person' on Changes in Fruit and Vegetable Consumption and Covariates, HILDA Survey 2009 and 2013

	Model 1 (no covariates)		Model 2 (partial set of covariates)		Model 3 (full set of covariates)	
Independent variable	β	*p*	β	*p*	β	*p*
Fruit and vegetable portions/day	0.02 [0.01, 0.04]	.000	0.02 [0.01, 0.04]	.001	0.02 [0.01, 0.03]	.006
Log of household income			-0.01 [-0.03, 0.03]	.790	-0.01 [-0.03, 0.03]	.823
Age			-0.02 [-0.04, 0.00]	.068	-0.02 [-0.04, 0.00]	.039
Age squared			0.01 [-0.01, 0.03]	.318	0.01 [-0.01, 0.03]	.205
Masters or doctorate			0.13 [-0.16, 0.42]	.374	0.14 [-0.15, 0.43]	.356
Bachelor or honors			0.00 [-0.27, 0.28]	.985	0.00 [-0.28, 0.28]	.994
Graduate diploma or certificate			0.14 [-0.08, 0.35]	.212	0.14 [-0.08, 0.36]	.219
Advanced diploma			0.13 [-0.10, 0.37]	.262	0.14 [-0.10, 0.37]	.253
Professional qualification			0.07 [-0.10, 0.25]	.422	0.07 [-0.11, 0.25]	.441
Year 12 high school			0.01 [-0.14, 0.15]	.912	0.02 [-0.13, 0.17]	.789
Full-time student			0.09 [-0.03, 0.20]	.154	0.09 [-0.03, 0.21]	.141
Unemployed			0.01 [-0.13, 0.16]	.854	0.01 [-0.14, 0.15]	.899
Not in the labor force			-0.10 [-0.17, -0.03]	.004	-0.11 [-0.18, -0.04]	.003
Married			0.00 [-0.12, 0.11]	.970	0.00 [-0.12, 0.11]	.951
Separated			-0.09 [-0.28, 0.11]	.393	-0.10 [-0.30, 0.09]	.300
Divorced			0.14 [-0.05, 0.34]	.155	0.14 [-0.06, 0.33]	.172
Widowed			0.00 [-0.28, 0.29]	.973	0.00 [-0.28, 0.29]	.989
Long-term health condition			-0.17 [-0.23, -0.11]	.000	-0.17 [-0.23, -0.11]	.000
# children under the age of 4			0.00 [-0.05, 0.05]	.969	0.00 [-0.04, 0.05]	.860
# children aged 5-14			-0.01 [-0.06, 0.03]	.647	-0.01 [-0.06, 0.03]	.648
Drink alcohol 1 or 2 days/week					-0.02 [-0.10, 0.06]	.607
Drink alcohol 2 or 3 days/week					0.02 [-0.05, 0.09]	.598
Drink alcohol 3 or 4 days/week					-0.06 [-0.15, 0.04]	.231
Drink alcohol 5 or 6 days/week					-0.08 [-0.19, 0.03]	.135
Drink alcohol everyday					-0.04 [-0.17, 0.09]	.549
Non-smoker					-0.04 [-0.13, 0.06]	.415
Never eat red meat					0.14 [-0.09, 0.38]	.232
Never eat fish					-0.03 [-0.12, 0.05]	.427
Eat breakfast regularly					0.04 [-0.02, 0.10]	.156
Drink low fat or skinny milk					0.00 [-0.05, 0.05]	.921
Avoid fatty foods					0.03 [-0.02, 0.09]	.190
BMI					0.00 [-0.01, 0.01]	.991
Exercise regularly					0.14 [0.09, 0.18]	.000
Constant	4.33 [4.28, 4.38]	.000	5.04 [4.53, 5.56]	.000	5.06 [4.51, 5.60]	.000
Overall R^2	.01		.01		.02	
Number of individuals	16,206		16,206		16,206	
Number of observations	23,917		23,917		23,917	

Note: Values in parentheses are 95% confidence intervals. Dependent variable is *Been a Happy Person* [range: 1-6].

Table S.12. Additional Life Satisfaction Equations: Instrumental-Variables Regression Models of 'Life Satisfaction' using 'Intensity of Go for 2&5 Campaign' as an Instrument for 'Fruit and Vegetable Consumption', HILDA Survey 2013

	Model 1 (no covariates)		Model 2 (partial set of covariates)		Model 3 (full set of covariates)	
Independent variable	β	*p*	β	*p*	β	*p*
Fruit and vegetable portions/day	0.10 [-0.93, 1.13]	.852	0.33 [-0.26, 0.92]	.276	0.31 [-0.24, 0.85]	.270
Log of household income			0.02 [-0.01, 0.05]	.165	0.02 [-0.01, 0.05]	.248
Other covariates included	No		Partial		Full	
Constant	7.56 [3.73, 11.39]	.000	7.83 [5.76, 9.90]	.000	7.88 [6.46, 9.30]	.000
Number of observations	13,788		13,788		13,788	

Note: Values in parentheses are 95% confidence intervals. Dependent variable is *Life Satisfaction* [range: 0-10]. The first-stage equations can be found in Table S.13.

Table S.13. First-Stage Regressions for Instrumented Life Satisfaction Equations in Table S.12: Regression Model of 'Fruit and Vegetable Consumption' on 'Intensity of Go for 2&5 Campaign', HILDA Survey 2013

	Model 1 (no covariates)		Model 2 (partial set of covariates)		Model 3 (full set of covariates)	
Independent variable	β	*p*	β	*p*	β	*p*
Intensity of campaign	0.01 [-0.003, 0.02]	.176	0.01 [0.003, 0.02]	.012	0.02 [0.01, 0.03]	.005
Log of household income			-0.01 [-0.05, 0.03]	.562	-0.03 [-0.07, 0.01]	.084
Other covariates included	No		Partial		Full	
Constant	3.68 [3.64, 3.73]	.000	3.40 [2.98, 3.83]	.000	2.51 [2.09, 2.94]	.000
First-stage *F*-statistic	1.83		6.31		8.05	
Number of observations	13,788		13,788		13,788	

Note: Values in parentheses are 95% confidence intervals. Dependent variable is *Fruit and Vegetable Consumption* (portions per day). First-stage *F*-statistic relates to a test of weak instruments, with a commonly suggested cutoff point of 10 for a strong instrument.

Table S.14. Additional Happiness Equations: Instrumental-Variables Regression Models of 'Been a Happy Person' using 'Intensity of Go for 2&5 Campaign' as an Instrument for 'Fruit and Vegetable Consumption', HILDA Survey 2013

	Model 1 (no covariates)		Model 2 (partial set of covariates)		Model 3 (full set of covariates)	
Independent variable	β	*p*	β	*p*	β	*p*
Fruit and vegetable portions/day	-0.38 [-1.39, 0.62]	.453	-0.00 [-0.43, 0.43]	.999	0.02 [-0.37, 0.42]	.907
Log of household income			0.01 [-0.01, 0.03]	.317	0.01 [-0.01, 0.03]	.439
Other covariates included	No		Partial		Full	
Constant	5.83 [2.12, 9.55]	.002	5.02 [3.52, 6.52]	.000	4.73 [3.70, 5.77]	.000
Number of observations	13,748		13,748		13,748	

Note: Values in parentheses are 95% confidence intervals. Dependent variable is *Been a happy person* [range: 1-6]. The first-stage equations can be found in Table S.15.

Table S.15. First-Stage Regressions for Instrumented Happiness Equations in Table S.14: Regression Model of 'Fruit and Vegetable Consumption' on 'Intensity of Go for 2&5 Campaign', HILDA Survey 2013

	Model 1 (no covariates)		Model 2 (partial set of covariates)		Model 3 (full set of covariates)	
Independent variable	β	*p*	β	*p*	β	*p*
Intensity of campaign	0.01 [-0.003, 0.02]	.169	0.01 [0.003, 0.02]	.011	0.02 [0.01, 0.03]	.004
Log of household income			-0.01 [-0.05, 0.03]	.541	-0.03 [-0.07, 0.01]	.078
Other covariates included	No		Partial		Full	
Constant	3.68 [3.64, 3.73]	.000	3.40 [2.98, 3.82]	.000	2.51 [2.08, 2.93]	.000
First-stage *F*-statistic	1.89		6.50		8.27	
Number of observations	13,748		13,748		13,748	

Note: Values in parentheses are 95% confidence intervals. Dependent variable is *Fruit and Vegetable Consumption* (portions per day). First-stage *F*-statistic relates to a test of weak instruments, with a commonly suggested cutoff point of 10 for a strong instrument.