The Association of TV Viewing Time with 2-h Plasma Glucose is Modified by a Prudent Dietary Pattern

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Running title: Dietary pattern modifies TV-viewing and glucose

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Abstract

Background

TV viewing is associated with elevated plasma glucose, but it's not clear whether such associations can be modified by dietary patterns.

Methods

We examined the interactions of TV viewing time and dietary patterns in relation to fasting and 2-h plasma glucose. Cross-sectional analyses were performed among participants (n= 3081; 44.7% male; mean age 57.8 years) from the 2011-2012 Australian Diabetes, Obesity and Lifestyle (AusDiab) study without clinically diagnosed diabetes or cardiovascular disease. Factor analysis (principal component) was conducted to identify dietary patterns. Multivariable

linear regression models were used to examine distinct associations of TV viewing time and dietary patterns with fasting and 2-hr plasma glucose. Dichotomous TV viewing time (low: <=2 hr/d vs high: >2 hr/d) and quartiles of dietary patterns were further combined to examine the joint associations with plasma glucose.

Results

Three dietary patterns were identified: prudent, western and mixed. TV viewing time was positively associated (β=0.01, p<0.05), and the prudent dietary pattern was inversely associated (β=-0.03, p<0.05) with 2-h plasma glucose. Compared to participants with high TV viewing/lowest prudent dietary pattern, participants with low TV viewing/highest prudent diet had the lowest 2-h plasma glucose (β=-0.05, p=0.028). No interactions were found between TV viewing time and the western dietary pattern, nor the mixed dietary pattern, in relation to either fasting or 2-h plasma glucose.

Conclusions

Following a prudent dietary pattern may attenuate the adverse effect of TV viewing on 2-h plasma glucose. Prospective studies and intervention trials are needed to further clarify these relationships.

Key words: TV viewing time, dietary patterns, glucose, Australian adults, AusDiab

Highlights

We used a 'posteriori' approach (factor analysis, principal component) to generate dietary patterns based on available dataset rather than a 'prior' approach based on pre-existing dietary guidelines (e.g. dietary quality index). The strengths include large sample size (n= 3081) with objectively measured fasting and 2-h plasma glucose and add new evidence on the interactions between sitting time (TV viewing) and dietary patterns particularly the benefits of healthy dietary pattern in relation to 2-h plasma glucose.

Introduction

Sedentary behaviour (characterised by a sitting, reclining or lying posture with low energy expenditure (1)) is associated detrimentally with cardiometabolic health outcomes (2). In Australian adults, sedentary behaviour can occupy an average of 39 hours per week, with 10 hours spent sitting at work, and 29 hours spent in leisure time sitting, including 13 hours of TV viewing time (3). As one major component of sedentary behaviour, TV viewing time particularly in high volumes has been shown to increase the risk of undiagnosed abnormal glucose metabolism (4), as well as type 2 diabetes, cardiovascular diseases and all-cause mortality (5). The detrimental relationships of TV viewing with adverse health outcomes may be influenced by concurrent behaviours such as snacking while watching TV (6). Higher volumes of TV viewing time can be associated with higher consumption of unhealthy foods including energy-dense snacks and drinks (7, 8).

TV viewing and snack food consumption (e.g. sweets, pastry, chips, ice cream) have been found to be both independently and jointly associated with metabolic syndrome and its components in Australian adults, particularly in women (9). High volumes of TV viewing time in conjunction with unhealthy snacking choices might reflect an unhealthy eating behaviour pattern in general. Dietary intake has been suggested as a potential mediator of the relationship of TV viewing time with elevated risk of type 2 diabetes, since associations have been shown to be attenuated following adjustment for dietary variables (5). This indicates a potential interplay between TV viewing time and diet in type 2 diabetes. The interactions between the whole diet and TV viewing in relation to diabetes risk thus require scientific scrutiny.

A joint effect of high TV viewing time (>14hs/week) and poorer dietary intake (assessed by a diet quality index) has been found previously to be associated with an elevated risk of abnormal

glucose metabolism in women but not in men (10). However, the diet quality index is a 'prior' approach given the index score is created on the basis of previous knowledge of a 'healthy' diet or prevailing dietary recommendations. In relation to this approach, the selection of individual components of the score may not be based on the best available evidence on diet and health (11). In contrast, an advantage of determining dietary patterns applying factor analysis using *a posteriori* approach is that this approach can generate patterns from available data that are unbiased by preceding hypotheses. Thus, it provides an alternative which may better account for the overall diet. This latter approach can better encompass possible interactions among foods and nutrients (11), and has been suggested to be particularly important for nutrition education and setting priorities in the planning of nutritional interventions (12). In the context of understanding sedentary behaviour/diet interactions, a study in France found high volumes of TV viewing time to be associated with 'convenience' and 'alcohol' dietary patterns (13), but how they interact in relation to risk of dysglycemia has not been investigated. No studies have specifically focused on the interactions between TV viewing time and dietary patterns in relation to fasting and 2-h plasma glucose – two key indicators of diabetes risk (dysglycemia) in adults. We examined the distinct and joint associations of TV viewing time and factor-analytically identified dietary patterns with fasting and 2-h plasma glucose in Australian adults.

Methods

Study population

The study population used in the current study was from the Australian Diabetes, Obesity and Lifestyle study (AusDiab), which is one of the largest national diabetes cohorts designed to examine the prevalence and incidence of diabetes and its associated risk factors. The detailed study design has been described elsewhere (14). In brief, over 11,000 adults participated at the baseline in 1999–2000, with another two follow-ups occurred in 2004-2005 (AusDiab2) and

2011-2012 (AusDiab3) respectively (14). The present study uses data from the 4200 participants in AusDiab3 with complete dietary intake assessments. After excluding ineligible participants (i.e. clinically diagnosed diabetes (n=279), pregnancy (n=4), cardiovascular diseases (n=80), kidney diseases (n=68), any missing covariates (n=658), implausible total sitting time (>18 hours/day, n=8) and those participants with missing primary sampling unit (cluster) based on census collector districts (n=8). The total sample included in the current study was 3094. The default option of the survey commands dropped 13 participants from the Australian capital territory as this state only had a single primary sampling unit, leading to a final sample of 3081 included for the analysis (see Figure 1). This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the Alfred Hospital Ethics Committee. Written informed consent was obtained from all participants.

Dietary measures

Dietary intake was measured using a semi-quantitative food frequency questionnaire (FFQ), which ascertains dietary intake over the last 12 months on a 10-point frequency scale, which has been validated in Australian population previously (15). Based on seven-day weighted food records, the FFQ has adequate correlations with total fat ($r = 0.68$), saturated fat ($r = 0.59$) and fibre ($r = 0.66$), adjusted for energy, with mean estimates of these nutrients agreeing to within ± 2 g (16). The FFQ includes 74 items with additional questions on food habits, portion size and alcoholic beverages. The intake of each food (in grams) was computed to daily equivalents for analyses，taking into account standard portion weights, using NUTTAB95 nutrient composition data (17).

TV viewing time

TV viewing time was self-reported by asking participants to recall the total time spent watching TV or videos in the previous week on weekdays and weekends respectively. This specified that TV viewing was required to be the main activity (i.e., does not include the time when TV or videos were just on and there were other activities undergoing concurrently). Weekly TV viewing per day was calculated using the total TV viewing hours (working days + weekends) divided by seven days. This measure has previously been shown to be reliable (intra-class correlation from 1-week test-retest [95% CI] = 0.82 [0.75, 0.87]) and valid in adults (criterion validity: comparison with a 3-day sedentary behaviour log; $\rho = 0.30$, $p < 0.01$) (18).

Glucose

A standard 75 g 2-hr oral glucose tolerance test was performed at a local testing centre for all participants after an overnight fast (minimum of 10 h), following the World Health Organisation (WHO) (19). Blood was withdrawn via venepuncture at Healthscope Pathology, Melbourne, Victoria. Fasting and 2-h plasma glucose concentrations were measured via a hexokinase method using the Siemens Advia 2400 (Siemens AG, Munich, Germany) instrument, which has been described elsewhere (20).

Potential confounding variables

Information including anthropometric factors, self-reported lifestyle variables such as leisure-time physical activity, smoking and alcohol consumption and sociodemographic data were collected. Physical activity (predominantly leisure time) was measured and categorised as sufficient (>=150 min/week) and insufficient (<150 min/week) according to the Active Australia Survey Questionnaire (21).

Statistical analyses

Dietary patterns

There were 102 food items in the FFQ. These were classified into 35 groups, with modifications made based on previous studies that followed the Australian Dietary Guidelines (22). Dietary patterns were identified using factor analysis (principal component method) with estimated daily intake (by grams) of these 35 food groups. Varimax rotation was used to improve interpretability and minimize the correlation between the factors. The final number of dietary patterns was determined by eigenvalue >1, scree plot, and interpretability of the factors (23). Factor loadings for each food group were calculated and factor scores for each pattern were calculated for each participant by summing the total grams of the 35 food groups weighted by their factor loadings.

Data analyses

Dietary factor scores were divided into quartiles based on their distribution in each stratum. Means and standard deviations across four quartiles were used to present the average consumption (grams) of each food group for each dietary pattern. Chi-square tests were used to compare differences between categorical variables, and ANOVA was used to compare differences in continuous variables between groups. The outcome variables (fasting and 2-h plasma glucose) were log transformed due to skewed distributions. Multivariable linear regression was used to examine the associations of quartiles of dietary patterns and TV viewing with fasting and 2-h plasma glucose levels. A set of multivariable models were used: model 1 adjusted for age and sex; model 2 further adjusted for occupation, education, marital status, exercise and smoking; model 3 further adjusted for waist circumference, total energy intake, and family history of diabetes. Joint associations between TV viewing and dietary patterns was further examined by combining two levels of TV viewing based on results from previous findings (24) (i.e. high TV viewing (>2 hr/d) and low TV viewing (<=2 hr/d)) and three categories of dietary patterns (quartile 1 (low), quartiles 2 and 3 were combined together into

category (moderate) to reduce the total number of combinations, and quartile 4 (high)). Post estimation commands such as 'margins' and 'marginsplot' were used to produce figures of joint association between dietary patterns and TV viewing against glucose levels. Three-way interactions were examined by adding multiplicative terms in the regression models to test if dietary patterns and TV viewing differs by other variables such age group, sex and waist circumference. We used survey commands in all the models to take into account the clustered stratified design. A sensitivity analysis was conducted, including participants dropped (n=13) by default under the 'svy' command by using the option 'singleunit (certainity)' wherein this stratum is included but does not contribute to the standard error of the estimates. All analyses were performed using STATA 16.0 (Stata Corporation, College Station, TX, USA). Statistical significance was set as two-sided $p<0.05$ (including for interaction terms).

Results

The median values (interquartile range [IQR]) for fasting plasma glucose and 2-h plasma glucose were 5.3 mmol/L (4.9-5.6 mmol/L) and 5.4 mmol/L (4.5-6.6 mmol/L) respectively. The means (SE) for TV viewing was 1.8 hours per day (0.03). There were about 33% of participants who reported more than 2 hours a day of TV viewing time.

Three major dietary patterns were identified: prudent dietary pattern; western dietary pattern; and mixed dietary pattern). Factor loadings of each dietary pattern are presented in Figure 2. The western dietary pattern consists of food groups such as take-away foods, snacks, processed meat and red meat. The mixed dietary pattern consists of food groups such as fish, cereals, pasta and rice and poultry. The prudent dietary pattern is characterised by food groups including vegetables (fruity, root and leafy) and fruits. Each of the three patterns explains 9.2%, 8.9%, and 8.5% of the variance in the food intake respectively.

Sample characteristics according to the three dietary patterns are presented in Table 1. Compared to those within the lowest quartiles, participants with the highest quartiles of mixed and western dietary patterns were younger, male, and with higher waist circumference, whereas participants within the highest quartiles of prudent dietary pattern were older, female and with lower waist circumference. Participants with higher prudent dietary pattern intakes tended to report less TV viewing time >2 hr/d. On the contrary, those with higher intake of the western dietary pattern tend to report more TV-viewing >2 hr/d. There were also differences observed in 2-h plasma glucose (presented by the median and interquartile range (IQR) across quartiles of the prudent dietary pattern. The 2-h plasma glucose level was significantly lower in the highest quartile of prudent dietary pattern (median 5.2 mmol/L, IQR 4.3-6.4) compared to the lowest quartile (5.6 mmol/L, IQR 4.7-6.8) (p=0.001, unadjusted ANOVA.

The distinct associations of TV viewing time and dietary patterns with fasting and 2-h plasma glucose (log transformed) are presented in Table 2. TV viewing was positively associated with 2-h plasma glucose (β=0.01, p<0.05) in model 3, adjusting for age, sex, occupation, physical activity, education, marital status, total energy intake, smoking, waist circumference and family history of diabetes. There was a consistent significant inverse association across all models between quartiles of prudent dietary pattern and 2-h plasma glucose. The positive association between western dietary pattern and 2-h plasma glucose was found in model 1 and 3, which was limited to the lower quartiles (Q2-3). There were no associations between any of the three dietary patterns and fasting glucose, except the significant association found with the mixed dietary pattern in higher quartiles (Q3-4) in all models.

The joint association between TV viewing and prudent dietary pattern is presented in Figure 3. With higher intake of prudent diet and lower TV viewing time, the level of 2-h plasma glucose continued to decrease in dose response (p for trend 0.001). Specifically, compared to

participants with high TV viewing (>2 hr/d) and lowest quartile of prudent dietary pattern (reference group), participants with the least risky combination of behaviours (low TV viewing (<=2 hr/d) and highest quartile of prudent dietary pattern) had the lowest 2-h plasma glucose level (β=-0.05, p=0.028) in fully-adjusted model (model 3).

The three-way interaction analysis examining whether the findings were affected by age, gender and waist circumference suggested no differences related to these factors. When we included the 13 participants within the single stratum, the significant joint association between categories of TV viewing and prudent dietary pattern and 2-h plasma glucose level remained significantly (data not shown).

Discussion

In a large sample of Australian adults, we found TV viewing time to be adversely associated, and a prudent dietary pattern to be beneficially associated, with 2-h plasma glucose but not with fasting glucose. Furthermore, we found lower levels of TV viewing time and a prudent dietary pattern to be jointly associated with lower 2-h plasma glucose levels. Specifically, participants with both lower TV viewing time and higher prudent dietary pattern had a lower 2-h glucose level compared to those who reported high TV viewing time and low prudent dietary pattern. There were no significant interactions between other dietary patterns and TV viewing in relation to 2-h plasma glucose, nor any of the dietary patterns and TV viewing in relation to fasting glucose. These findings have potential implications for diabetes prevention and management, suggesting that having the prudent dietary pattern that we identified may partly offset the detrimental glycaemic relationships observed with higher volumes of TV viewing time.

Our findings on dietary patterns are in line with previous studies showing that a relatively healthy dietary pattern is associated with reduced risk, and that a relatively unhealthy dietary

pattern can be associated with increased risk of diabetes (25). While we found no associations between either the prudent or the western dietary pattern and fasting glucose, there was an association for 2-h plasma glucose. This is consistent with an earlier study in Australian older adults, which found that neither the prudent nor western dietary pattern was associated with fasting glucose, but a strong association was found between dietary patterns and the risk of type 2 diabetes (26). The mechanism of the effect of diet on diabetes development may extend beyond the direct impact on fasting glucose.

TV viewing time was found to be significantly associated with higher 2-h plasma glucose in the present study. Those who reported TV-viewing >2 hr/d were more likely to have a higher intake of the western dietary pattern; and, by contrast those who less likely to report TV-viewing >2 hr/d were more likely to have higher intake of the prudent dietary pattern. An interaction was observed only between TV viewing and a prudent dietary pattern (and not the western nor the mixed patterns) in relation to 2-h plasma glucose. A novel finding of our study, with potential clinical implications, is that the detrimental effect of TV viewing on 2-h plasma glucose may be offset by having a prudent dietary pattern. Although the benefits seem to be small (5.6+ mmol/L in High TV+ Low prudent diet group VS 5.4 mmol/L in Low TV + High Prudent diet group, Figure 3), it is not unexpected given that we included only those who were free from diabetes. There is a linear relationship between glucose and CVD risks even within normal glucose range (27), that 1 mmol/L higher of random glucose was associated with 8-11% higher of CVD risks in 467,508 adults free of diabetes. From a prevention perspective, glucose elevations are to be minimized given the impact it has on chronic disease development. The interaction between TV viewing time and diet has also been studied previously using the same cohort in Australia, showing a significant joint effect, specifically the combination of poorer diet quality and high TV viewing time had the strongest association with abnormal glucose metabolism (10). It could be expected that TV viewing time and the western dietary

pattern would have a synergistic detrimental association with plasma glucose, given the joint adverse relationship with diet quality seen in the previous study (10), but this was not apparent. On the contrary, when we compared to the least healthy combination (high TV viewing and low prudent dietary pattern), the healthiest combination (low TV viewing and high prudent dietary pattern) had the lowest 2-h plasma glucose level. A potential mechanism could be an inflammation-reducing role of a prudent dietary pattern. A prudent dietary pattern has been consistently associated with reduced inflammation and related cardiometabolic conditions (28). A healthy diet rich in antioxidants may increase the level of anti-inflammatory cytokines in the body that may further protect from metabolic dysfunction. A plant-sourced nutrient pattern has been previously suggested to be associated with reduced C-reactive protein levels in a sample of Australian men, and the associations seemed to be stronger among those with sedentary lifestyle, although the interaction was not significant (29).

Unlike previous studies that have found significant gender differences in the joint association between TV viewing and diet quality (10) or snack consumption (9) in relation to cardiometabolic risk, there was no gender difference in joint association between TV viewing and prudent dietary pattern in relation to 2-h plasma glucose. However, we did observe a gender difference in the independent positive association between TV viewing and 2-h glucose, which was only significant in women but not in men (data not shown). This is consistent with previous studies that demonstrated stronger associations between TV time and glycemic outcomes in women compared to men (30, 31). Whether there is a gender difference in the independent association between dietary patterns and cardiometabolic risk is inconclusive (32, 33). In our study, no gender difference was seen in the association between prudent dietary pattern and 2-h plasma glucose level (data not shown).

Strengths of this study include the large sample, the objectively measured blood glucose (including fasting and 2-h plasma glucose), and comprehensive assessment of lifestyle

behaviours. Nevertheless, there are some limitations needed to be clarified. By investigating dietary patterns, which may represent a regular dietary habit in our sample, however, we do not have time-based dietary intake measures, nor evidence on when and for how long TV viewing took place after a particular type of food intake. In addition, the food questionnaire was validated in 1990s, and had no information regarding sugar sweetened beverage and drinks like tea or coffee. Since sugar sweetened beverage has been widely confirmed to have detrimental effects in cardiometabolic conditions, which can be independent of adiposity (9, 34), the inclusion of sweetened beverage intake could have strengthened the power of dietary pattern analysis and its related associations. The majority of our sample are middle and older, such that young adults were not well represented and thus, generalizability of our findings may be limited. Other limitations include the cross-sectional study design, that prohibits determination of causality, and self-reported TV viewing time and dietary intake. However, as this is the first study assessing the interactions between TV viewing and dietary patterns, it provides initial evidence of possible inter-relationships between diet and TV viewing on glucose metabolism to inform future longitudinal studies and intervention trials.

Conclusion

Previous observational and intervention studies (35-37) have confirmed the beneficial associations with respect to glycaemic outcomes and other aspects of cardiometabolic risk of reducing and breaking up sitting time, and our findings add new insight on the interactions between sitting time and dietary patterns, particularly the benefits of healthy dietary pattern in this context. Prospective studies are needed to clarify the potential beneficial effect on cardiometabolic health of a healthy dietary pattern in the context of TV viewing time and other context-specific sitting.

Disclosure: None conflicts of interest.

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Table 1. Characteristics of participants according to the 1st and 4th quartiles of the dietary pattern score for three dietary patterns among AusDiab cohort (n=3081) †

	Prudent dietary pattern		Western dietary pattern		Mixed dietary pattern	
	Q1 (n=772)	Q4 (n=772)	Q1 (n=773)	Q4 (n=770)	Q1 (n=769)	Q4 (n=770)
Age (years), mean (SE)	56.3 (0.4)	58.7 (0.3)	58.7 (0.3)	56.2 (0.4)	60.4 (0.4)	56.3 (0.3)
Male (%)	28.6	24.5	9.4	44.0	23.2	30.9
Waist (cm), mean (SE)	95.1 (0.5)	92.3 (0.5)	89.5 (0.6)	98.1 (0.5)	92.3 (0.5)	96.6 (0.7)
Marital status						
Married/de facto	23.5	25.3	23.7	25.9	23.7	25.3
Not married/de facto	31.3	23.9	30.8	21.2	30	23.8
Household income						
Low (<AUS$40k)	24.8	24.7	24	23.4	39.6	18.4
Mid (AUS$40k-$80k)	24	27.3	25	22.6	25.1	23.3
High (>AUS$80k)	25.8	23.9	25.7	27.2	17.9	29.2
Physical activity (%)						
Insufficient (<150 min/week)	30.3	19.2	21.5	28.6	28.7	23.6
Sufficient (>150 min/week)	22.4	28	26.9	23.1	23	25.7

Current smoker (%)	36.5	21.7	12.6	43.9	25.7	30.4
Occupation categories (%)						
Professional	24.1	25.7	26.7	23.3	17.5	30.4
Blue collar	27.6	26.3	10.8	48.2	26.6	27.6
White collar	27.6	24.4	32.1	20.6	23.1	25.6
Not currently working	23.6	24.3	24.4	20.7	34.1	17.5
Education (%)						
Secondary	28	22	27.5	23.5	27.1	23.6
Trade	25.8	24.1	18.4	32.3	27.8	25.1
Associated/diploma	21.3	28	27.5	19.9	22.4	24.2
University and above	22.9	28.1	28.3	21.4	20.7	27.1
Family history of diabetes (%)						
Yes	24.6	24.2	27.4	24.8	24.7	25.8
No	25.2	25.4	24.2	25.1	25.1	24.7
Carbohydrate (g/d), mean (SE)	156.4 (2.2)	218.7 (2.9)	134.5 (1.7)	247.2 (2.9)	173.5 (2.8)	204.2 (2.9)
Protein (g/d), mean (SE)	78.0 (1.0)	103.0 (1.4)	73.0 (1.1)	117.2 (1.82)	69.6 (0.9)	119.3 (2.0)
Fat (g/d), mean (SE)	66.6 (1.1)	84.8 (1.2)	49.8 (0.6)	106.7 (1.4)	63.3 (1.0)	91.0 (1.5)

Energy intake (KJ/d), mean (SE)	6400.2 (86.1)	8549.1 (105.2)	5339.4 (63.2)	10068.5 (120.9)	6426.5 (91.0)	8814.7 (128.7)
TV-viewing>2 hr/d (%)	27.3	24.8	21.6	30.4	27.3	25
Fasting glucose (ml/L) (IQR)	5.3 (5-5.6)	5.3 (4.9-5.6)	5.2 (4.9-5.5)	5.4 (4.9-5.6)	5.2 (4.9-5.6)	5.4 (5-5.7)
2-h plasma glucose (ml/L) (IQR)	5.6 (4.7-6.8)	5.2 (4.3-6.5)	5.3 (4.5-6.3)	5.4 (4.4-6.6)	5.5 (4.5-6.7)	5.3 (4.4-6.6)

† Results are from unadjusted ANOVA, corrected for complex survey design using survey commands; The total number of participants for analysis is subtracted from the sample of 4200 participants at stage 3 (2011-2012) who did not meet the eligibility for analysis, such as pregnancy, heart disease, diagnosed diabetes, and with missing values on covariates. IQR stands for interquartile range (25%-75%).

Table 2. Associations of TV viewing time and dietary patterns with fasting and log transformed 2-h plasma glucose †

	Fasting plasma glucose			2-hrour plasma glucose		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
TV viewing	0.00 (0.00, 0.01)*	0.00 (-0.00, 0.01)	0.00 (-0.00, 0.01)	0.02 (0.01, 0.03)**	0.01 (0.00, 0.02)*	0.01 (0.00, 0.02)*
Prudent dietary pattern						
Q1 (ref)						
Q2	-0.00 (-0.01, 0.01)	-0.00 (-0.01, 0.01)	-0.00 (-0.01, 0.01)	-0.04 (-0.07, -0.01)*	-0.04 (-0.07, -0.00)*	-0.03 (-0.06, 0.00)
Q3	-0.00 (-0.01, 0.01)	0.00 (-0.01, 0.01)	0.00 (-0.01, 0.01)	-0.05 (-0.07, -0.02)**	-0.04 (-0.07, -0.02)**	-0.03 (-0.06, -0.01)*
Q4	-0.01 (-0.02, 0.01)	-0.00 (-0.01, 0.01)	0.00 (-0.01, 0.02)	-0.07 (-0.10, -0.04)**	-0.06 (-0.09, -0.02)**	-0.03 (-0.07, -0.00)*
Western dietary pattern						
Q1 (ref)						
Q2	0.00 (-0.01, 0.01)	-0.00 (-0.01, 0.01)	-0.00 (-0.02, 0.01)	0.03 (0.00, 0.06)*	0.03 (-0.00, 0.06)	0.03 (0.00, 0.06)*
Q3	0.00 (-0.01, 0.01)	0.00 (-0.01, 0.01)	-0.00 (-0.01, 0.01)	0.03 (0.00, 0.07)*	0.02 (-0.01, 0.06)	0.03 (0.00, 0.07)*
Q4	0.01 (-0.01, 0.02)	0.00 (-0.01, 0.01)	-0.00 (-0.01, 0.01)	0.01 (-0.03, 0.05)	-0.01 (-0.04, 0.03)	0.01 (-0.03, 0.05)

Mixed dietary

pattern

  Q1 (ref)

Q2	0.01 (-0.00, 0.02)	0.01 (-0.00, 0.02)	0.00 (-0.00, 0.01)	-0.01 (-0.04, 0.02)	-0.01 (-0.04, 0.02)	-0.01 (-0.04, 0.02)
Q3	0.02 (0.01, 0.03)**	0.02 (0.01, 0.03)**	0.01 (0.00, 0.02)**	0.03 (-0.00, 0.05)	0.03 (0.00, 0.06)*	0.03 (-0.00, 0.06)
Q4	0.03 (0.02, 0.04)**	0.03 (0.02, 0.04)**	0.02 (0.01, 0.03)**	0.01 (-0.03, 0.04)	0.01 (-0.02, 0.05)	0.01 (-0.03, 0.05)

†Results are from multivariable linear regression (95% CI), corrected for complex survey design, based on available observations for fasting glucose

(n=3081) and 2-hrour plasma (n=3070)

Model 1 adjusted for age and sex

Model 2 further adjusted for occupation, exercise, education, marital status, and smoking

Model 3 further adjusted for total energy intake, waist circumference and family history of diabetes

*p<0.05. **p<0.01

Figure 1. Flow chart of present study population

*Participants with abnormal total sitting time (eg. >18 hours/day)

**Participants from ACT were excluded from analysis because this stratum had only single sampling unit

Figure 2. Factor loadings of dietary patterns according to factor analysis using all sample of AusDiab of stage 3 (2011-2012) (n=4200)

Figure 3. Joint association between categories of TV viewing and prudent dietary pattern and 2-h plasma glucose level (95%CI) in adults from AusDiab cohort (n=3070). High TV /Low prudent diet: >2 hr/d TV & Q1 of prudent dietary pattern; Low TV/Low prudent diet:<=2 hr/d TV & Q1 of prudent dietary pattern; High TV/Moderate prudent diet:>2 hr/d TV & (Q2 &Q3) of prudent dietary pattern; High TV/High prudent diet: >2 hr/d TV & Q4 of prudent dietary pattern; Low TV/Moderate prudent diet: <=2 hr/d TV & (Q2 &Q3) of prudent dietary pattern; Low TV/High prudent diet: <=2 hr/d TV & Q4 of prudent dietary pattern. Model 3 was used.

Q1: quartile 1, Q2: quartile 2, Q3: quartile 3, Q4: quartile 4

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┌─────────────────────────────┐
│ Study population (AusDiab    │
│ stage 3, n=4200 with         │
│ complete dietary intake),    │
│ 2011-2012                    │
└─────────────────────────────┘
              │
              │          ┌──────────────────────────────────┐
              │          │ Ineligible participants:         │
              │          │ •Clinically diagnosed diabetes   │
              │          │ (n=279)                          │
              │          │ •Pregnancy (n=4)                 │
              ├──────────│ •Heart diseases (n=80)           │
              │          │ •Kidney problem (n=69)           │
              │          │ •Any missing covariates (n=658)  │
              │          │ •Abnormal total sitting time*    │
              │          │ (n=8)                            │
              │          │ •Missing clusters based on       │
              │          │ census collector districts (n=8) │
              │          └──────────────────────────────────┘
              │
     ┌─────────────────────┐
     │ Total sample included│
     │ in the current study │
     │ (n=3094)             │
     └─────────────────────┘
              │
┌────────────────────────┐
│ Stratum had only        │
│ single sample unit      ├──
│ dropped by using        │
│ svyset** (n=13)         │
└────────────────────────┘
              │
     ┌─────────────────────┐
     │ Eligible for analysis│
     │ 2-hour plasma        │
     │ glucose (n=3070)     │
     │ Fasting plasma       │
     │ glucose (n=3081)     │
     └─────────────────────┘
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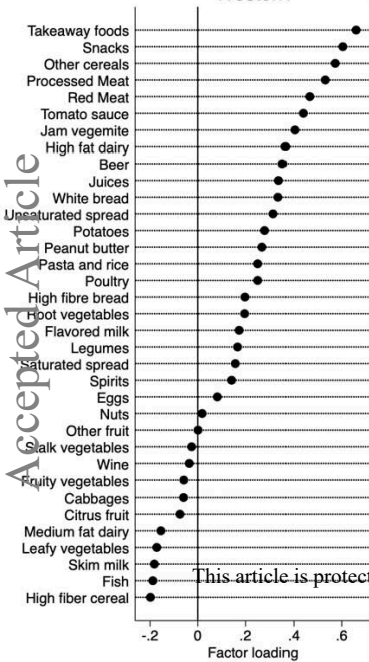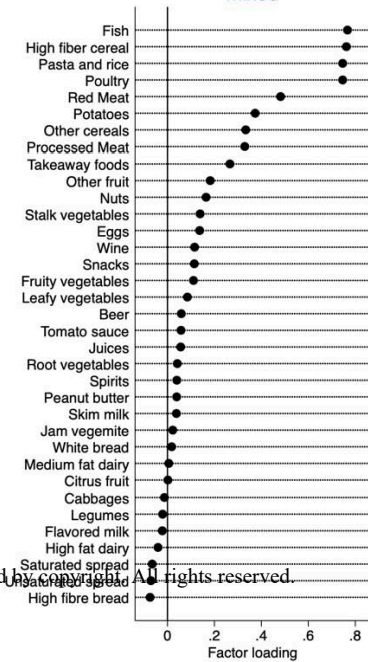
| Western | Mixed | Prudent |