Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women

Authors: Marina M Reeves[a], Genevieve N Healy[a,b], Neville Owen[b], Jonathan E Shaw[b], Paul Z Zimmet[b], David W Dunstan[b,c,d,e]

[a*] The University of Queensland, School of Population Health, Cancer Prevention Research Centre, Level 3 Public Health Building, Herston Road, Herston, Queensland 4006 AUSTRALIA [*]Institution where the work was carried out

[b] Baker IDI Heart and Diabetes Institute, 75 Commercial Road, Melbourne, Victoria 3004 AUSTRALIA

[c] Deakin University, School of Exercise and Nutrition Sciences, 221 Burwood Highway, Burwood, Victoria 3125 AUSTRALIA

[d] Monash University, Department of Epidemiology and Preventive Medicine, The Alfred Centre, 99 Commercial road, Melbourne, Victoria 3004 AUSTRALIA

[e] The University of Western Australia, School of Sport Science, Exercise and Health, 35 Stirling Highway, Crawley, Western Australia 6009 AUSTRALIA

Corresponding author: Marina M Reeves

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

The University of Queensland, School of Population Health, Cancer Prevention Research Centre, Level 3 Public Health Building, Herston Road, Herston, Queensland 4006 AUSTRALIA
Ph: +61 7 3365 4692; Fax: +61 7 3365 5540; Email: m.reeves@sph.uq.edu.au

Email addresses:

MMR: m.reeves@sph.uq.edu.au; GNH: g.healy@sph.uq.edu.au; NO: neville.owen@bakeridi.edu.au; JES: jonathan.shaw@bakeridi.edu.au; PZZ: paul.zimmet@bakeridi.edu.au; DWD: david.dunstan@bakeridi.edu.au

Word count abstract: 189; **Word count main text:** 2606

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

Abstract

Objective: To examine the independent and joint associations of diet quality and television viewing time with abnormal glucose metabolism (AGM) in men and women.

Method: Cross-sectional data from 5346 women and 4344 men from the 1999-2000 Australian Diabetes, Obesity and Lifestyle Study were examined. Diet quality scores were derived from a food frequency questionnaire and categorised into tertiles (high; moderate; low). Television viewing time was dichotomised into low (≤14 hours/week) and high (>14 hours/week). AGM was defined as impaired fasting glucose, impaired glucose tolerance, known or newly diagnosed diabetes based on an oral glucose tolerance test. Regression analyses adjusted for confounding variables.

Results: Diet quality and television viewing time were significantly associated with AGM in women, independent of waist circumference. Compared to women with high diet quality/low television viewing time, women with low diet quality/low television

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

viewing time and women with low diet quality/high television viewing time were significantly more likely to have AGM. Associations were not observed in men. **Conclusions:** Both poor diet quality and prolonged television viewing should be addressed to reduce risk of AGM in women. Further understanding of modifiable risk factors in men is warranted.

Key words: food habits; television; glucose metabolism disorders; sedentary lifestyle

Introduction

Abnormal glucose metabolism (AGM; impaired fasting glucose [IFG], impaired glucose tolerance [IGT], known or newly diagnosed diabetes mellitus) has been linked to increased risk of cardiovascular disease (Bartnik et al., 2007; Coutinho et al., 1999; Levitan et al., 2004) and premature all-cause mortality (Barr et al., 2007; Barr et al., 2009). Sedentary behaviours, such as high television viewing time (Dunstan et al., 2004; Hu et al., 2001; Hu et al., 2003), and poor dietary intake (Fung et al., 2007; Montonen et al., 2005; van Dam et al., 2002) have been identified as independent modifiable risk factors for AGM and type 2 diabetes. These studies have often reported stronger adverse associations between the behaviours and glycemic outcomes in women than in men (Dunstan et al., 2004; Montonen et al., 2005).

Television viewing has been associated with increased overall caloric intake (Bowman, 2006; Hu et al., 2003; Jeffery and French, 1998) and increased intakes of snack foods, sweets/desserts and added sugars (Bowman, 2006; Hu et al., 2003). While this highlights that joint associations showing the combined effects of television viewing and diet quality bear scrutiny, joint associations have not been examined. Such insights are important for informing preventive approaches to address the worldwide diabesity epidemic (Zimmet et al., 2001). Therefore, in a large population-based sample, this study examined the independent and joint associations of television viewing time and overall dietary quality with AGM in men and women. Dietary quality was summarized in terms of overall consistency with dietary recommendations (Diet Quality Index- Revised; Haines et al., 1999).

Methods

Sample

Data were from the baseline sample (1999/2000) of the Australian Diabetes, Obesity and Lifestyle (AusDiab) study: a national, population-based, cross-sectional survey of Australian adults aged ≥25 years. The AusDiab study methods and representativeness have previously been described (Dunstan et al., 2002a). Briefly, a stratified cluster-sampling method was used, with households from 42 randomly selected urban and non-urban Census Collector Districts (six per state/territory) approached. Of the 20,347 eligible people who completed a household interview, 11,247 (55.3%) attended a biomedical examination.

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

For this analysis we excluded as ineligible those who were pregnant (n=60); we also excluded those with missing data for AGM status (n=113), diet quality (n=1154), television viewing time (n=47) or covariates (n=184), leaving 5346 women and 4344 men available for these analyses (86.6% of eligible participants). This study was approved by the human research ethics committee at the Baker IDI Heart & Diabetes Institute. Written informed consent was obtained from all participants.

Measures and data management

Participants attended a local survey site for a biomedical examination, where a 2-hour oral glucose tolerance test was performed, following an overnight fast (minimum 9 hours). Fasting plasma glucose (FPG) and 2-hour plasma glucose (2-hr PG) levels were obtained by enzymatic methods (Olympus AU600 analyser; Olympus Optical, Tokyo, Japan). The WHO criteria were used to defined IFG (FPG ≥6.1 and <7.0mmol/L with 2-hour PG <7.8mmol/L), IGT (2-hour PG ≥7.8 and <11.1 mmol/L with FPG <7.0mmol/L) and diabetes mellitus (FPG ≥7.0mmol/L or 2-hour PG ≥11.1mmol/L) (World Health Organization, 1999). Participants who reported having physician-diagnosed diabetes and were either taking hypoglycemic medications or met the criteria for diabetes were classified as known diabetes. Presence of any of these conditions was categorised as AGM.

Dietary assessment and calculation of diet quality

Dietary intake was assessed using a self-administered food frequency questionnaire (FFQ), recalling intake over the previous 12-months (Ireland et al., 1994). The FFQ has adequate correlations with seven-day weighed food records for 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 grams (Hodge et al., 2000). The FFQ includes 74 items (with 10 frequency options), with additional questions on food habits, portion size

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

and alcoholic beverages. Nutrient intakes were computed, taking into account standard portion weights, using NUTTAB95 nutrient composition data (Lewis et al., 1995). Total energy intakes between 500 to 3500 kcal/day for women and 800 to 4000 kcal/day for men were considered valid (Willett, 1998).

Using the FFQ data, diet quality was then calculated using the Diet Quality Index – Revised score (Haines et al., 1999; Newby et al., 2003) which rates 10 dietary components (total fat, saturated fat, dietary cholesterol, fruit, vegetables, grains, calcium, iron, dietary diversity and dietary moderation) relative to national dietary recommendations. Here, the Australian standards were used (Australian Government Department of Health and Ageing and National Health and Medical Research Council, 2005; Australian Government Department of Health and Ageing et al., 2006). Scores from the ten components were summed (0-100), with higher scores indicating better diet quality. Continuous scores were normally distributed, ranging from 22.55 to 97.93. These were also categorised in tertiles (low: 0.00-56.87; moderate: 56.88-69.35; high: 69.36-100.00).

Television viewing time

Total television viewing time (hours/week) was ascertained by interviewer-administered questionnaire, during which participants reported the total time spent watching television or videos, where this was the main activity, in the previous week on weekdays and weekend days (separately). This television viewing time measure is reliable (intra-class correlation from 1-week test-retest [95%CI] = 0.82 [0.75, 0.87]) and valid (criterion validity: comparison with a 3-day sedentary behavior log; $\rho = 0.30$, $p < 0.01$) (Salmon et al., 2003). Total television viewing time was examined continuously and dichotomised as either high (>14 hours/week) or low (≤14 hours/week) based on associations previously observed (Dunstan et al., 2004).

Joint diet quality and television viewing time

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

Joint effects were examined by classifying diet quality (low, moderate, high) and television viewing (low, high) into their six possible combinations.

Adiposity

Height (nearest 0.5cm) and weight (nearest 0.1kg) were measured without shoes and excess clothing, and used to calculate body mass index (BMI; kg/m^2) (Dunstan et al., 2001). Waist circumference, as an indicator of central adiposity, was measured (to the nearest 0.5cm) at the midpoint between the lower border of the lowest rib and the superior border of the iliac crest using a non-expandable measuring tape. Duplicate measurements were taken with the average used (Dunstan et al., 2001).

Covariates

The interviewer-administered questionnaire included data on demographic attributes, parental history of diabetes, current cigarette smoking status, and alcohol intake. Physical activity (predominantly leisure time) was measured via the Active Australia questionnaire (Australian Institute of Health and Welfare, 2003). Participants were categorised as being sufficiently active if their total physical activity time was ≥ 150 minutes/week (Australian Government Department of Health and Ageing, 1999).

Statistical analysis

All analyses were conducted using Stata version 11 (StataCorp LP, 2003). To account for clustering and stratification in the survey design and for non-response, linearized variance estimation was used (survey commands) and data were weighted to the 1998 estimated residential Australian population (Dunstan et al., 2002a).

The independent and joint relationships of diet quality and television viewing time with AGM were examined using logistic regression analyses. A significant interaction was observed between diet quality and television viewing time ($p=0.028$), hence the joint effect was relevant to examine. Models were presented stratified by gender in view

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

of prior literature (Dunstan et al., 2004; Montonen et al., 2005). Potential confounders were identified based on associations with AGM at the bivariate level in men and/or women. Regression models were adjusted for: age, parental history of type 2 diabetes, pre-existing cardiovascular disease (myocardial infarction, angina, stroke), education, income, employment status, menopausal status (women only), height, smoking status, alcohol intake, total energy intake, physical activity category and television viewing time/diet quality as appropriate (Model A). Previous studies have suggested that associations between television time and glycemic outcomes may be mediated through central adiposity (Stamatakis and Hamer, 2012; Ford et al., 2010; Dunstan et al., 2004). So, in a separate model we further adjusted for waist circumference (Model B). Covariates remaining statistically significant in the final model included: age, height, waist circumference and parental history of type 2 diabetes (both men and women), smoking status and exercise (women only) and total energy intake (men only). Data from the models are reported as odds ratios and 95% confidence intervals. Statistical significance for main effects was set at $p < 0.05$ (two-tailed).

Results

Participants were on average (Mean ± SD) aged 48.2 ± 15.4 years (from 25 to 95 years) with a mean BMI of 26.6 ± 4.9kg/m^2. Characteristics of the 9,690 participants included in the analysis and those excluded are shown in Supplementary Table 1. Those included in the analysis were generally similar to those excluded, except for their slightly higher education and income levels.

The prevalence of AGM in men was 24.8% (95%CI: 21.8, 27.8) and 21.8% (95%CI: 18.8, 24.7) in women, including 7.6% (95%CI: 6.1, 9.1) of men and 6.3% (95%CI: 4.8, 7.8) of women with newly diagnosed or known diabetes. Women had a higher overall diet quality score (65.5 ± 13.7) compared to men (59.8 ± 12.5; p<0.001)

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

and fewer women reported high television viewing time (30.9%, 95% CI: 27.1, 34.9) compared to men (35.8%, 95% CI: 32.9, 38.8; p=0.007). Table 1 shows the attributes of study participants, by gender and by diet quality tertiles. Women and men with low diet quality were significantly more likely to report high television viewing time compared to those with high diet quality. In women, BMI and waist circumference did not differ across diet quality tertiles. However, men with moderate and low diet quality had significantly higher BMI and waist circumference than men with high diet quality. BMI and waist circumference were both significantly higher in men and women with high television viewing time compared to those with low television viewing time ($p < 0.001$; Supplementary Table 2).

INSERT TABLE 1 ABOUT HERE

Diet quality

Women with low diet quality had significantly higher odds of AGM than women with high diet quality (Table 2). This association was slightly attenuated but remained statistically significant following adjustment for waist circumference (Table 2, Model B). When diet quality was examined as a continuous variable, the odds of AGM decreased significantly for every 10-unit increase in the diet quality score (OR = 0.85; 95%CI 0.78, 0.93, p = 0.001). No significant association was observed between diet quality and AGM in men.

INSERT TABLE 2 ABOUT HERE

Television viewing time

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

Television viewing time was significantly associated with AGM in women but not in men. Women with high television viewing time had significantly higher odds of AGM than women with low television viewing time (Table 2). This association was partly attenuated after adjustment for waist circumference but remained statistically significant. For every 30-minute increase in television viewing time, the odds of AGM increased (OR = 1.01; 95%CI 1.00, 1.01, p <0.001).

Joint associations with diet quality and television viewing time

Both with and without adjustment for waist circumference, joint associations of diet quality and television viewing time were significant in women (p=0.003 and p<.001) but not in men (p=0.116 and p=0.265). In women, adjusting for waist circumference, relative to those with both high diet quality and low television viewing time (the referent group), those with the most risky combination of behaviours (low dietary quality/high television viewing) had 1.8-fold higher odds of AGM (OR=1.81, 95% CI: 1.18, 2.76, p =.007) while those with only one of these risk factors had less pronounced, or no elevations in odds of AGM (Figure 1). For women, no significant increase in odds of AGM relative to the referent group was observed with high television viewing in combination with high or moderate diet quality (OR=1.15, 95 CI: 0.89, 1.50, p=0.282 and OR=1.31, 0.96, 1.79, p=.083). Combined with low television viewing, women with low diet quality had significantly higher odds of AGM (OR=1.50, 95% CI: 1.08, 2.09, p=.018) while those with moderate diet quality did not (OR = 0.82, 95%CI: 0.61, 1.08, p=.154), relative to the referent group. Considering also the prevalence of these risk factors, 28% (95% CI: 25.3, 31.2) of women had the optimal combination of behaviours (high dietary quality/low television viewing time), 8.6% (95% CI: 7.2, 10.1%) of women had the most risky combination (high television viewing/low dietary quality) and 18.0% (16.2, 20.0%) of women had low dietary quality/low television viewing, which was associated with significantly elevated odds of AGM.

INSERT FIGURE 1 ABOUT HERE

Sensitivity analyses that excluded participants with known diabetes and pre-existing cardiovascular disease (who could have altered their behaviors as a result of their diagnoses), showed the same overall conclusions as these main analyses, but with slightly attenuated associations.

Discussion

Almost one in four Australian adults has AGM – these rates are similar to those observed in the US in non-Hispanic whites (Cowie et al., 2006) and are expected to continue to increase (Dunstan et al., 2002b). This study provides further evidence that diet quality and television viewing time are independent risk factors for AGM. It also extends previous research to examine the joint association of these modifiable behaviours on AGM status. As anticipated, those with both of these unhealthy behaviours (poor diet quality and high television viewing time) were at the greatest risk of AGM, though this was only evident in women (1.8-fold higher odds). In women, there was a substantial prevalence (26.6%) of combined television viewing and diet quality that could be considered at substantial risk of AGM (significant association with OR ≥1.5).

Previous research has shown that the association between sedentary behaviour and cardio-metabolic risk factors is largely mediated through adiposity (Stamatakis and Hamer, 2012). In our study, while the association of television viewing time with AGM

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

in women was attenuated by adiposity, it still remained statistically significant. Mediation by adiposity appears less likely for diet quality, as these associations were unaffected by adjustment for waist circumference. Previous research has also shown that diet quality is associated with risk of type 2 diabetes in women, independent of central adiposity (Fung et al., 2007). Poor diet quality has been shown to be the strongest behavioural predictor of gain in waist circumference over five years (Walls et al., 2011). Taken together, this study further highlights that improving diet quality in line with national dietary guidelines is an important public health target for improving glycemic health and preventing obesity, particularly for women. A ten point improvement in diet quality is associated with almost 20% decreased odds of AGM. A ten point improvement could be achieved by: an additional one serving of fruit and one serving of vegetables per day, and by using skim milk in a latte coffee instead of full cream milk.

The significant associations observed between television viewing time and diet quality with AGM in this study were exclusively only observed in women. This is consistent with previous literature where stronger associations between television viewing time (and self-reported computer use) and with glycemic outcomes have been observed in women compared to men (Bertrais et al., 2005; Dunstan et al., 2007; Dunstan et al., 2004; Dunstan et al., 2005; Ford et al., 2005). Associations between dietary patterns and type 2 diabetes risk have also differed between men and women (Montonen et al., 2005). The reason for this gender difference in associations remains unclear – whether there are real biological differences or an artefact of the behaviours measured. For example, while television viewing is the most commonly reported leisure time sedentary behaviour in Australian men and women (Salmon et al., 2003; Sugiyama et al., 2008), it appears to be a marker of a broader pattern of leisure time sedentary behaviour in women only (Sugiyama et al., 2008). Further, no meaningful gender

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

differences have been observed when device-based measures of sedentary time are used (Healy et al., 2011b).

Strengths and Limitations

Strengths of this study included the large population-based sample, the objective blood glucose measures, detailed anthropometric measurements and a comprehensive assessment of lifestyle behaviours. The main limitations include the cross-sectional study design, limiting inferences regarding causality, and the self-reported assessment of diet and television viewing time. We examined overall dietary quality and adjusted for total caloric intake, however there may be some residual confounding as certain aspects of dietary intake, such as glycemic load, and behaviour, such as snacking were not measured. It is unclear whether overall dietary intake or specific aspects of dietary intake are more important for glycemic health. There may have been some selection bias, as there was an underrepresentation of minority ethnic groups and lower socio-economic groups in the AusDiab study (Dunstan et al., 2002a) coupled with a tendency for low SES groups to be excluded due to missing data. As lower socio-economic groups tend to have poorer dietary intakes (Darmon and Drewnowski, 2008) and higher television viewing time (Bowman, 2006; Salmon et al., 2000) the strength of the associations reported here may be underestimated.

Prospective studies are needed to clarify the temporal associations between diet quality, television viewing time and blood glucose outcomes. Such studies should incorporate device-based, as well as contextual measures of sedentary time (Healy et al., 2011a). Measures of dietary intake could also include measures of specific dietary behaviours, such as snacking, which may help to determine whether there are other dietary aspects that explain some of the gender differences that we have observed in these associations.

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

Conclusion

In women, poor diet quality and prolonged television viewing time are detrimentally associated with glycemic outcomes independent of central adiposity, particularly in combination. Findings provided some evidence of the importance (for women) for prevention of AGM of a diet in line with national recommendations and of minimising sedentary behaviour in the form of television viewing, particularly in women with poor dietary quality. Further studies to understand modifiable risk factors for abnormal glucose metabolism in men are warranted.

Abbreviations

AGM, abnormal glucose metabolism; IFG, impaired fasting glucose; IGT, impaired glucose tolerance; FPG, fasting plasma glucose; 2-hr PG, 2-hour plasma glucose; FFQ, Food Frequency Questionnaire; BMI, Body Mass Index

Conflict of Interest Statement

The authors declare that there are no conflicts of interest.

Acknowledgements

Reeves has been supported by a National Health and Medical Research Council (NHMRC) Early Career Fellowship (#389500) and a National Breast Cancer Foundation Early Career Fellowship. Healy is supported by a NHMRC Early Career Fellowship (#569861) and NHMRC Program Grant funding (#569940). Owen was supported by a NHMRC Program Grant (#569940), a NHMRC Senior Principal Research Fellowship (#1003960), and by the Victorian Government's Operational Infrastructure Support Program. Dunstan is supported by an Australian Research Council

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

Future Fellowship (#FT100100918) and the Victorian Health Promotion Foundation. This research work was supported by a NHMRC project grant (#233200). In addition, the AusDiab study has received financial support from the Australian Government Department of Health and Ageing, Abbott Australasia, Alphapharm, AstraZeneca, Aventis Pharma, Bio-Rad Laboratories, Bristol-Myers Squibb, City Health Centre Diabetes Service Canberra, Department of Health and Community Services Northern Territory, Department of Health and Human Services Tasmania, Department of Health New South Wales, Department of Health Western Australia, Department of Human Services South Australia, Department of Human Services Victoria, Diabetes Australia, Diabetes Australia Northern Territory, Eli Lilly Australia, Estate of the Late Edward Wilson, GlaxoSmithKline, Highpoint Shopping Centre, Jack Brockhoff Foundation, Janssen-Cilag, Kidney Health Australia, Marian & EH Flack Trust, Menzies Research Institute, Merck Sharp & Dohme, Multiplex, Novartis Pharmaceuticals, Novo Nordisk Pharmaceuticals, Pfizer Pty Ltd, Pratt Foundation, Queensland Health, Roche Diagnostics Australia, Royal Prince Alfred Hospital Sydney and Sanofi-Synthelabo. The funding sources reported above had no involvement in the study design; collection, analysis and interpretation of data; writing of the report; and the decision to submit the article for publication. For their invaluable contribution to the set-up and field activities of AusDiab, we are enormously grateful to A Allman, B Atkins, S Bennett, S Chadban, S Colagiuri, M de Courten, M Dalton, M D'Embden, T Dwyer, D Jolley, I Kemp, P Magnus, J Mathews, D McCarty, A Meehan, K O'Dea, P Phillips, P Popplewell, C Reid, A Stewart, R Tapp, H Taylor, T Welborn and F Wilson. We are also grateful to Tanya Khan for her assistance with scoring the dietary data for the dietary quality index.

References

American Academy of Pediatrics - Committee on Public Education, 2001. Children, adolescents, and television. Pediatrics 107**,** 423-426.

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

Australian Government Department of Health and Ageing, 1999. National Physical Activity Guidelines for Australians. Australian Government Department of Health and Ageing, Canberra.

Australian Government Department of Health and Ageing, 2004a. Australia's Physical Activity Recommendations for 5-12 year olds. Australian Government Department of Health and Ageing, Canberra.

Australian Government Department of Health and Ageing, 2004b. Australia's Physical Activity Recommendations for 12-18 year olds. Australian Government Department of Health and Ageing, Canberra.

Australian Government Department of Health and Ageing, National Health and Medical Research Council, 2005. Food for health: Dietary guidelines for Australians, a guide to health eating. Australian Government Department of Health and Ageing, Canberra.

Australian Government Department of Health and Ageing, National Health and Medical Research Council, New Zealand Ministry of Health, 2006. Nutrient reference values for Australia and New Zealand: Executive summary. National Health and Medical Research Council, Canberra.

Australian Institute of Health and Welfare, 2003. The Active Australia Survey. A guide and manual for implementation, analysis and reporting. Australian Institute of Health and Welfare, Canberra.

Barr, E.L., Zimmet, P.Z., Welborn, T.A., Jolley, D., Magliano, D.J., Dunstan, D.W., Cameron, A.J., Dwyer, T., Taylor, H.R., et al., 2007. Risk of cardiovascular and all-cause mortality in individuals with diabetes mellitus, impaired fasting glucose, and impaired glucose tolerance: the Australian Diabetes, Obesity, and Lifestyle Study (AusDiab). Circulation 116**,** 151-157.

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

Barr, E.L., Boyko, E.J., Zimmet, P.Z., Wolfe, R., Tonkin, A.M., Shaw, J.E., 2009. Continuous relationships between non-diabetic hyperglycaemia and both cardiovascular disease and all-cause mortality: the Australian Diabetes, Obesity, and Lifestyle (AusDiab) study. Diabetologia 52**,** 415-424.

Bartnik, M., Norhammar, A., Ryden, L., 2007. Hyperglycaemia and cardiovascular disease. J. Intern. Med. 262**,** 145-156.

Bertrais, S., Beyeme-Ondoua, J.P., Czernichow, S., Galan, P., Hercberg, S., Oppert, J.M., 2005. Sedentary behaviors, physical activity, and metabolic syndrome in middle-aged French subjects. Obes. Res. 13**,** 936-944.

Bowman, S.A., 2006. Television-viewing characteristics of adults: correlations to eating practices and overweight and health status. Prev. Chronic. Dis. 3**,** A38.

Coutinho, M., Gerstein, H.C., Wang, Y., Yusuf, S., 1999. The relationship between glucose and incident cardiovascular events. A metaregression analysis of published data from 20 studies of 95,783 individuals followed for 12.4 years. Diabetes Care 22**,** 233-240.

Cowie, C.C., Rust, K.F., Byrd-Holt, D.D., Eberhardt, M.S., Flegal, K.M., Engelgau, M.M., Saydah, S.H., Williams, D.E., Geiss, L.S., et al., 2006. Prevalence of diabetes and impaired fasting glucose in adults in the U.S. population: National Health and Nutrition Examination Survey 1999-2002. Diabetes Care 29, 1263-1268.

Darmon, N., Drewnowski, A., 2008. Does social class predict diet quality? Am. J. Clin. Nutr. 87**,** 1107-1117.

Dunstan, D., Zimmet, P., Welborn, T., Sicree, R., Armstrong, T., Atkins, R., Cameron, A., Shaw, J., Chadban, S., 2001. Diabesity & associated disorders in Australia - 2000 - The accelerating epidemic: The Australian diabetes, obesity and lifestyle study (AusDiab). International Diabetes Institute, Melbourne.

Dunstan, D.W., Zimmet, P.Z., Welborn, T.A., Cameron, A.J., Shaw, J., de Courten, M., Jolley, D., McCarty, D.J., 2002a. The Australian Diabetes, Obesity and Lifestyle Study (AusDiab) - methods and response rates. Diabetes Res. Clin. Pract. 57**,** 119-129.

Dunstan, D.W., Zimmet, P.Z., Welborn, T.A., De Courten, M.P., Cameron, A.J., Sicree, R.A., Dwyer, T., Colagiuri, S., Jolley, D., et al., 2002b. The rising prevalence of diabetes and impaired glucose tolerance: the Australian Diabetes, Obesity and Lifestyle Study. Diabetes Care 25, 829-834.

Dunstan, D.W., Salmon, J., Owen, N., Armstrong, T., Zimmet, P.Z., Welborn, T.A., Cameron, A.J., Dwyer, T., Jolley, D., et al., 2004. Physical activity and television viewing in relation to risk of undiagnosed abnormal glucose metabolism in adults. Diabetes Care 27**,** 2603-2609.

Dunstan, D.W., Salmon, J., Owen, N., Armstrong, T., Zimmet, P.Z., Welborn, T.A., Cameron, A.J., Dwyer, T., Jolley, D., et al., 2005. Associations of TV viewing and physical activity with the metabolic syndrome in Australian adults. Diabetologia 48**,** 2254-2261.

Dunstan, D.W., Salmon, J., Healy, G.N., Shaw, J.E., Jolley, D., Zimmet, P.Z., Owen, N., 2007. Association of television viewing with fasting and 2-h postchallenge plasma glucose levels in adults without diagnosed diabetes. Diabetes Care 30**,** 516-522.

Ford, E.S., Kohl 3rd, H.W., Mokdad, A.H., Ajani, U.A., 2005. Sedentary behavior, physical activity, and the metabolic syndrome among U.S. adults. Obes. Res. 13**,** 608-614.

Ford, E.S., Schulze, M.B., Kroger, J., Pischon, T., Bergmann, M.M., Boeing, H., 2010. Television watching and incident diabetes: Findings from the European Prospective Investigation into Cancer and Nutrition-Potsdam Study. J. Diabetes 2, 23-27.

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

Fung, T.T., McCullough, M., van Dam, R.M., Hu, F.B., 2007. A prospective study of overall diet quality and risk of type 2 diabetes in women. Diabetes Care 30**,** 1753-1757.

Haines, P.S., Siega-Riz, A.M., Popkin, B.M., 1999. The Diet Quality Index revised: a measurement instrument for populations. J. Am. Diet. Assoc. 99**,** 697-704.

Healy, G.N., Clark, B.K., Winkler, E.A., Gardiner, P.A., Brown, W.J., Matthews, C.E., 2011a. Measurement of adults' sedentary time in population-based studies. Am. J. Prev. Med. 41**,** 216-227.

Healy, G.N., Matthews, C.E., Dunstan, D.W., Winkler, E.A., Owen, N., 2011b. Sedentary time and cardio-metabolic biomarkers in US adults: NHANES 2003-06. Eur. Heart J. 32**,** 590-597.

Hodge, A., Patterson, A.J., Brown, W.J., Ireland, P., Giles, G., 2000. The Anti Cancer Council of Victoria FFQ: relative validity of nutrient intakes compared with weighed food records in young to middle-aged women in a study of iron supplementation. Aust. N. Z. J. Public Health 24**,** 576-583.

Hu, F.B., Leitzmann, M.F., Stampfer, M.J., Colditz, G.A., Willett, W.C., Rimm, E.B., 2001. Physical activity and television watching in relation to risk for type 2 diabetes mellitus in men. Arch. Intern. Med. 161**,** 1542-1548.

Hu, F.B., Li, T.Y., Colditz, G.A., Willett, W.C., Manson, J.E., 2003. Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. JAMA 289**,** 1785-1791.

Ireland, P., Jolley, D., Giles, D., O'Dea, K., Powles, J., Rautishauser, I., Wahlqvist, M.L., Williams, J., 1994. Development of the Melbourne FFQ: a food frequency questionnaire for use in an Australian prospective study involving an ethnically diverse cohort. Asia Pacific J Clin Nutr 3**,** 19-31.

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

Jeffery, R.W., French, S.A., 1998. Epidemic obesity in the United States: are fast foods and television viewing contributing? Am. J. Public Health 88**,** 277-280.

Levitan, E.B., Song, Y., Ford, E.S., Liu, S., 2004. Is nondiabetic hyperglycemia a risk factor for cardiovascular disease? A meta-analysis of prospective studies. Arch. Intern. Med. 164**,** 2147-2155.

Lewis, J., Milligan, G., Hunt, A., 1995. NUTTAB95 Nutrient data table for use in Australia. Australian Government Publishing Service, Canberra.

Montonen, J., Knekt, P., Harkanen, T., Jarvinen, R., Heliovaara, M., Aromaa, A., Reunanen, A., 2005. Dietary patterns and the incidence of type 2 diabetes. Am. J. Epidemiol. 161**,** 219-227.

Newby, P.K., Hu, F.B., Rimm, E.B., Smith-Warner, S.A., Feskanich, D., Sampson, L. Willett, W.C., 2003. Reproducibility and validity of the Diet Quality Index Revised as assessed by use of a food-frequency questionnaire. Am. J. Clin. Nutr. 78**,** 941-949.

Salmon, J., Bauman, A., Crawford, D., Timperio, A., Owen, N., 2000. The association between television viewing and overweight among Australian adults participating in varying levels of leisure-time physical activity. Int. J. Obes. Relat. Metab. Disord. 24**,** 600-606.

Salmon, J., Owen, N., Crawford, D., Bauman, A., Sallis, J.F., 2003. Physical activity and sedentary behavior: a population-based study of barriers, enjoyment, and preference. Health Psychol. 22**,** 178-188.

Stamatakis, E., Hamer, M., 2012. The extent to which adiposity markers explain the association between sedentary behavior and cardiometabolic risk factors. Obesity 20**,** 229-232.

StataCorp LP, 2003. Stata Data Analysis and Statistical Software (Release 10.0). StataCorp LP, College Station, TX.

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

Sugiyama, T., Healy, G.N., Owen, N., Dunstan, D.W., Salmon, J., 2008. Is television viewing time a marker of a broader pattern of sedentary behavior? Ann. Behav. Med. 35**,** 245-250.

van Dam, R.M., Rimm, E.B., Willett, W.C., Stampfer, M.J., Hu, F.B., 2002. Dietary patterns and risk for type 2 diabetes mellitus in U.S. men. Ann. Intern. Med. 136**,** 201-209.

Walls, H.L., Magliano, D.J., McNeil, J.J., Stevenson, C., Ademi, Z., Shaw, J., Peeters, A., 2011. Predictors of increasing waist circumference in an Australian population. Public Health Nutr. 14**,** 870-881.

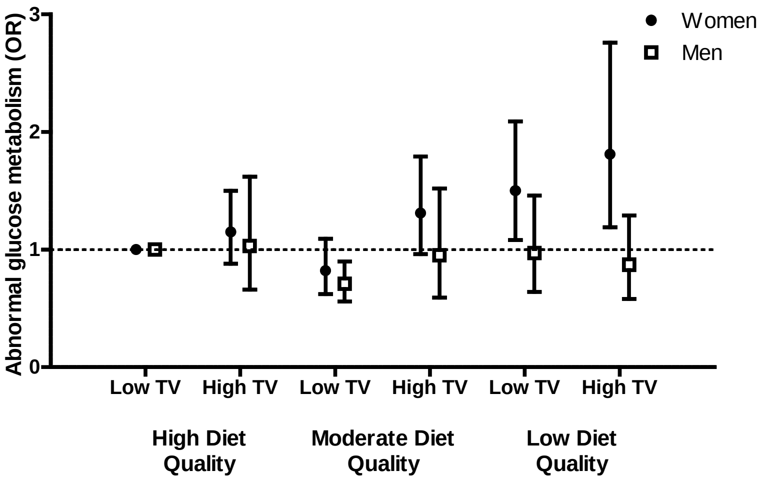
Willett, W. 1998. Nutritional Epidemiology. Oxford University Press, New York.

World Health Organization, 1999. Definition, diagnosis and classification of diabetes mellitus and its complications: Report of a WHO Consultation. Part 1. Diagnosis and classification of diabetes mellitus. World Health Organization, Geneva.

Zimmet, P., Alberti, K.G., Shaw, J., 2001. Global and societal implications of the diabetes epidemic. Nature 414**,** 782-787.

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine, 57* 5: 471-476.

Figure 1 - Adjusted odds ratios and 95% CI for abnormal glucose metabolism in women (•) and men (□) within the joint diet quality and television viewing (TV) time categories



Adjusted for age, height, pre-existing CVD, parental history of type 2 diabetes, education level, household income level, employment status, menopausal status (women only), smoking status, alcohol intake, total energy intake, physical activity level and waist circumference.

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

Table 1 - Selected characteristics by diet quality tertile of the 5346 women and 4344 men aged 25 years or older in the AusDiab study (Australia, 1999-2000)

	Women			Men		
		Diet quality			**Diet quality**	
	Low	**Moderate**	**High**	**Low**	**Moderate**	**High**
N	1401	1776	2169	1827	1456	1061
Age (years)	43.0	48.3	52.0	43.9	48.6	52.0
	(40.7, 45.4)[a]	(46.2, 50.4)[a]	(49.9, 54.1)	(42.6, 45.2)[a]	(46.6, 50.6)[a]	(49.8, 54.1)
Body mass index (kg/m^2)	26.0	26.2	26.3	27.0	27.1	26.5
	(25.3, 26.8)	(25.7, 26.7)	(25.7, 26.8)	(26.7, 27.2)[a]	(26.6, 27.5)[a]	(26.1, 26.8)
Waist circumference (cm)	82.9	83.5	83.9	96.3	96.2	94.8
	(80.7, 85.1)	(82.0, 84.9)	(81.9, 85.9)	(95.5, 97.1)[a]	(94.8, 97.7)[a]	(93.3, 96.4)
Height	162.0	162.6	162.3	176.1	176.0	175.6
	(161.3, 162.8)[a]	(161.8, 163.4)	(161.9, 162.8)	(175.2, 177.1)	(175.3, 176.7)	(174.6, 176.6)
Fasting plasma glucose (mmol/L)	5.3	5.3	5.3	5.6	5.6	5.6
	(5.2, 5.3)	(5.2, 5.3)[a]	(5.3, 5.4)	(5.5, 5.6)	(5.5, 5.6)	(5.5, 5.7)
2-hour plasma glucose (mmol/L)	6.3	6.2	6.4	5.9	6.1	6.4
	(6.1, 6.5)[a]	(6.1, 6.4)	(6.1, 6.6)	(5.8, 6.0)	(5.8, 6.3)	(6.1, 6.6)
Abnormal glucose metabolism (%)	22.0	19.7	23.3	22.2	24.5	30.2
	(17.9, 26.6)[a]	(16.5, 23.4)	(19.7, 27.3)	(19.1, 25.7)	(20.4, 29.1)	(24.6, 36.4)
Pre-existing cardiovascular disease	4.2	6.9	7.3	4.2	7.6	11.6
(%)	(2.1, 8.0)	(4.7, 10.1)	(5.1, 10.3)	(3.2, 5.5)[a]	(5.7, 10.0)	(8.8, 15.1)
Parental history of diabetes (%)						
Yes	20.5	17.7	19.4	17.1	16.0	14.5

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

	(16.9, 24.6)	(14.0, 22.2)	(17.0, 22.1)	(13.4, 21.5)	(14.0, 18.2)	(12.0, 17.3)
No	70.8	73.0	73.8	70.4	73.1	76.4
	(65.5, 75.6)	(68.1, 77.5)	(70.8, 76.6)	(66.3, 74.2)	(68.5, 77.3)	(72.7, 79.7)
Don’t know/missing	8.7	9.3	6.8	12.5	10.9	9.2
	(6.8, 11.0)	(7.3, 11.7)	(5.2, 8.8)	(9.8, 15.9)	(7.3, 16.0)	(7.4, 11.3)
Highest education level (%)						
Bachelor degree or higher	15.5	18.8	15.1	17.5	23.7	33.1
	(10.7, 21.8)	(14.9, 23.3)	(11.6, 19.4)	(12.6, 23.8)[a]	(18.9, 29.3)[a]	(26.8, 40.1)
Certificate, diploma etc	36.3	37.2	43.7	50.1	51.6	44.0
	(30.8, 42.2)[a]	(33.8, 40.6)[a]	(40.0, 47.4)	(45.3, 54.9)[a]	(46.9, 56.3)	(38.2, 50.0)
High school or less	48.2	44.1	41.3	32.4	24.7	22.9
	(43.1, 53.4)[a]	(38.2, 50.2)	(36.6, 46.1)	(27.0, 38.4)	(21.2, 28.5)	(18.5, 27.9)
Household income (%)						
≥ $1,500/week	15.0	18.2	14.6	18.9	20.7	23.2
	(10.2, 21.5)	(13.5, 24.0)	(10.0, 20.8)	(12.9, 26.9)	(15.5, 27.1)	(15.7, 32.9)
< $1,500/week	83.2	80.1	83.6	80.6	79.1	75.8
	(76.8, 88.2)	(74.1, 84.9)	(77.5, 88.3)	(72.7, 86.6)[a]	(72.7, 84.3)	(66.2, 83.5)
No response/missing	1.8	1.8	1.8	0.5	0.2	0.9
	(1.0, 3.2)	(1.2, 2.8)	(1.2, 2.7)	(0.2, 1.1)	(0.1, 0.6)	(0.5, 1.9)
Employed (%)	60.7	52.4	49.5	78.7	73.1	67.6
	(54.6, 66.4)	(44.7, 59.8)	(44.5, 54.4)	(75.0, 82.0)	(68.4, 77.4)	(62.3, 72.5)
Menopausal (%)	31.1	43.6	56.9			
	(24.1, 39.0)[a]	(38.0, 49.4)[a]	(51.5, 62.0)			
Current cigarette smoker (%)	27.1	14.8	8.2	29.3	12.4	5.9

	(21.6, 33.5)[a]	(11.6, 18.7)[a]	(5.4, 12.1)	(24.7, 34.3)[a]	(9.7, 15.7)[a]	(4.3, 8.0)
Moderate, heavy alcohol drinkers	22.2	16.6	14.2	42.6	33.0	25.9
(%)	(17.0, 28.5)[a]	(12.7, 21.4)	(11.5, 17.5)	(37.8, 47.7)[a]	(27.9, 38.5)[a]	(21.9, 30.4)
Total energy intake (kJ/d)	7477	7435	7175	10357	9677	8849
	(7255, 7699)	(7284, 7586)[a]	(7034, 7315)	(10201, 10513)[a]	(9463, 9892)[a]	(8597, 9101)
Sufficient physical activity (%)	39.4	46.3	54.2	50.7	60.9	66.5
	(34.9, 44.1)[a]	(40.5, 52.2)[a]	(50.5, 57.8)	(47.2, 54.2)[a]	(57.5, 64.2)[a]	(60.9, 71.6)
Television viewing >14 hrs/wk (%)	32.1	30.8	30.1	40.5	33.1	30.7
	(29.0, 35.4)[a]	(26.5, 35.6)[a]	(25.3, 35.3)	(36.8, 44.3)[a]	(29.7, 36.7)	(25.0, 37.1)

Data are means (95% CI) or proportion (95% CI). Data (unadjusted means and proportions) are weighted to the Australian population.

[a]$p < 0.05$, with high diet quality as referent (multinomial logistic regression analysis), adjusted for age.

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine, 57* 5: 471-476.

Table 2 - Independent associations of diet quality and television viewing time with abnormal glucose metabolism (AGM) in women and men in the AusDiab study (Australia, 1999-2000)

		Diet quality				Television viewing time		
	Model	**High**	**Moderate**	**Low**	***p* for trend**	**Low ≤14 hrs/wk**	**High >14 hrs/wk**	***p* for difference**
Women	*n*	2169	1776	1401		3574	1772	
	A	Ref	0.95 (0.79, 1.14)	**1.55 (1.21, 1.98)**	**0.003**	Ref	**1.48 (1.29, 1.71)**	**<0.001**
	B	Ref	0.94 (0.77, 1.13)	**1.53 (1.15, 2.03)**	**0.012**	Ref	**1.29 (1.07, 1.57)**	**0.011**
Men	*n*	1061	1456	1827		2689	1655	
	A	Ref	0.85 (0.68, 1.06)	1.04 (0.74, 1.44)	0.733	Ref	1.19 (0.93, 1.51)	0.161
	B	Ref	0.78 (0.60, 1.03)	0.91 (0.65, 1.28)	0.705	Ref	1.05 (0.80, 1.37)	0.708

AGM includes impaired fasting glucose, impaired glucose tolerance, known or newly diagnosed diabetes mellitus

Data are odds ratios and 95% confidence intervals

Model A: adjusted for age, height, pre-existing CVD (yes/no), parental history of type 2 diabetes(yes/no/unknown), education level (high school or less/certificate or diploma etc / bachelor degree or higher), household income level (≥$1500 per week /<$1500 per week /no response or missing), employed (yes/no), menopausal status (women only: peri- or post-menopause/pre-menopause), smoking status (ex- or non-smoker/current smoker), alcohol intake (non-drinker/light drinker/moderate-heavy drinker), total energy intake (kJ/d), physical activity level (inactive/insufficiently active/sufficiently active) and TV time/diet quality (as appropriate).

Model B: also adjusted for waist circumference

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

Supplementary Table 1 – Characteristics of AusDiab study participants included and those excluded from the analysis (Australia, 1999-2000)

	Included	Excluded[a]	*p*
n	9690	1497	
Age (years)	48.2 ± 15.4	49.5 ± 15.3	0.242
Gender			0.502
Men	49.3 (4344)	50.4 (705)	
Women	50.7 (5346)	49.6 (792)	
Body mass index (kg/m^2)	26.6 ± 4.9	27.0 ± 5.0[b]	0.123
Waist circumference (cm)	89.9 ± 13.8	90.9 ± 13.0[b]	0.137
Height (cm)	169.0 ± 9.9	168.1 ± 9.5[b]	0.087
Fasting plasma glucose (mmol/L)	5.5 ± 1.1	5.6 ± 1.2[b]	0.034
2-hour plasma glucose (mmol/L)	6.2 ± 2.4	6.3 ± 2.0[b]	0.153
Abnormal glucose metabolism:			0.019
Yes	23.3 (2551)	26.5 (420)	
No	76.7 (7139)	73.5 (964)	
Parental history of diabetes:			<0.001
Yes	17.6 (1764)	17.9 (257)	
No	72.7 (6963)	67.0 (1005)	
Don't know/missing	9.6 (963)	15.2 (235)	
Pre-existing cardiovascular disease:			0.006
Yes	6.7 (765)	10.5 (155)	
No	93.3 (8925)	89.5 (1284)	
Highest education level:			<0.001
Bachelor degree or higher	19.7 (1665)	13.5 (198)	
Certificate, diploma etc	44.3 (4117)	40.6 (561)	
High school or less	36.0 (3908)	45.9 (738)	
Household income:			<0.001
≥ $1,500/week	18.2 (1631)	10.7 (173)	
< $1,500/week	80.7 (7931)	84.6 (1227)	
No response/missing	1.2 (128)	4.7 (97)	
Employment status:			0.012
Employed	63.7 (5815)	52.0 (736)	
Not employed	36.3 (3875)	48.0 (698)	
Smoker status:			0.122
Current smoker	16.9 (1595)	21.7 (255)	
Ex- or never-smoker	83.1 (8095)	78.3 (1149)	
Self-reported alcohol intake:			0.024

Moderate-heavy drinker	26.2 (2486)	22.2 (321)	
Light drinker	57.6 (5650)	55.4 (784)	
Non-drinker	16.2 (1554)	22.4 (329)	
Physical activity level:			0.365
Sufficiently active	52.6 (5073)	49.9 (699)	
Insufficiently active	31.5 (2959)	34.3 (436)	
Inactive	15.9 (1658)	15.8 (256)	
Television viewing time:			0.167
>14 hours/week	33.3 (3427)	38.1 (525)	
≤14 hours/week	66.7 (6263)	61.9 (883)	

Data are mean ± standard deviation or proportion (n), weighted to the Australian population

[a] Excluded due to missing data (does not include n=60 who were ineligible due to pregnancy)

[b] Body mass index (n=1377); waist circumference (n=1363); height (n=1468); fasting plasma glucose (n=1495); 2-hour plasma glucose (n=1019)

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

Supplementary Table 2 - Selected characteristics by TV viewing time of the 4641 women and 3624 men aged 25 years or older in the AusDiab study (Australia, 1999-2000)

	Women		**Men**	
	Television viewing		**Television viewing**	
	Low (≤14 hrs/wk)	**High (>14 hrs/wk)**	**Low (≤14 hrs/wk)**	**High (>14 hrs/wk)**
N	3574	1772	2689	1655
Age (years)	46.0 (44.4, 47.5)	53.9 (51.3, 56.5)	46.3 (45.1, 47.6)	48.9 (46.4, 51.4)
Body mass index (kg/m^2)	25.5 (25.1, 26.0)	27.6 (27.1, 28.1)[a]	26.6 (26.3, 26.9)	27.4 (27.1, 27.7)[a]
Waist circumference (cm)	81.8 (80.2, 83.3)	87.4 (85.8, 89.0)[a]	95.0 (94.0, 96.0)	97.7 (96.6, 98.7)[a]
Height (cm)	162.9 (162.4, 163.4)	161.0 (160.4, 161.6)[a]	176.4 (175.6, 177.1)	175.3 (174.5, 176.1)
Fasting plasma glucose (mmol/L)	5.2 (5.2, 5.3)	5.5 (5.4, 5.5)[a]	5.5 (5.5, 5.6)	5.7 (5.6, 5.7)[a]
2-hour plasma glucose (mmol/L)	6.0 (5.8, 6.2)	7.0 (6.7, 7.3)[a]	5.9 (5.8, 6.1)	6.3 (5.9, 6.6)
Abnormal glucose metabolism (%)	16.9 (14.6, 19.4)	32.6 (28.8, 36.7)[a]	22.3 (19.9, 24.9)	29.3 (24.7, 34.4)[a]

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

Parental history of diabetes (%)				
Yes	18.9 (17.0, 20.9)	19.7 (17.3, 22.3)	15.8 (13.7, 18.2)	16.7 (14.4, 19.4)
No	74.0 (71.6, 76.3)	69.9 (67.3, 72.4)[a]	74.0 (71.2, 76.5)	70.4 (66.3, 74.2)
Don't know/missing	7.1 (5.9, 8.4)	10.4 (8.8, 12.4)	10.3 (8.5, 12.3)	12.9 (11.0, 15.2)
Pre-existing cardiovascular disease (%)	4.5 (3.5, 5.6)	10.5 (7.4, 14.7)[a]	6.0 (4.7, 7.5)	8.9 (7.3, 10.8)
Highest education level (%)				
Bachelor degree or higher	19.9 (16.4, 24.0)	8.5 (5.9, 12.2)[a]	27.8 (23.2, 32.8)	14.9 (10.4, 20.9)[a]
Certificate, diploma etc	42.1 (39.8, 44.4)	33.9 (29.7, 38.5)[a]	46.7 (42.8, 50.5)	53.7 (49.3, 58.1)
High school or less	38.1 (34.1, 42.2)	57.5 (52.0, 62.9)	25.6 (21.3, 30.4)	31.4 (27.2, 35.9)
Household income (%)				
≥ $1,500/week	19.5 (14.7, 25.5)	7.8 (5.1, 11.7)[a]	24.3 (18.0, 31.9)	13.7 (8.8, 20.7)
< $1,500/week	78.8 (72.8, 83.8)	90.2 (85.9, 93.3)[a]	75.2 (67.7, 81.4)	85.8 (78.8, 90.8)[a]
No response/missing	1.7 (1.2, 2.4)	2.0 (1.2, 3.1)	1.0 (0.3, 1.0)	0.5 (0.2, 1.1)

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.

Employed (%)	62.1 (57.9, 66.1)	33.9 (29.6, 38.5)[a]	80.3 (77.4, 82.9)	63.6 (58.0, 68.9)[a]
Menopausal (%)	38.5 (34.3, 42.9)	61.5 (54.3, 68.2)[a]		
Current cigarette smoker (%)	14.9 (11.8, 18.6)	16.6 (12.4, 21.9)[a]	15.0 (12.4, 18.0)	24.4 (20.3, 28.9)[a]
Moderate, heavy alcohol drinkers (%)	18.3 (14.9, 22.2)	14.5 (11.9, 17.7)	34.6 (30.6, 38.8)	37.4 (33.3, 41.8)
Total energy intake (kJ/d)	7335 (7220, 7449)	7361 (7185, 7537)	9751 (9578, 9924)	9879 (9580, 10178)
Sufficient physical activity (%)	48.6 (43.8, 53.4)	45.6 (41.0, 50.2)	59.1 (54.9, 63.2)	55.1 (50.4, 59.7)
Diet Quality Score	65.6 (64.6, 66.6)	65.1 (64.0, 66.1)	60.6 (59.4, 61.8)	57.7 (56.5, 58.9)

Data are means (95% CI) or proportion (95% CI). Data (unadjusted means and proportions) are weighted to the Australian population.

[a] $p < 0.05$ compared to low television viewing time, adjusted for age.

This is a post-print version of the following article: Reeves, Marina M., Healy, Genevieve N., Owen, Neville, Shaw, Jonathan E., Zimmet, Paul Z. and Dunstan, David W. (2013) Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Preventive Medicine*, *57* 5: 471-476.