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Mealtime habits and risk of developing the metabolic syndrome or insulin resistance among Mexican adults

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The contribution of each author to this research study is as follows: P. M.-H. and L. D. D.-C. were involved in the design of the study, statistical analysis and writing of the manuscript. C. S., B. R.-P., L. C.-P., R. P., M. M.-G. and Y. N. F. helped in drafting the manuscript. E. R.-L. and E. S.-M. assisted with the statistical analysis and contributed to writing the manuscript. J. S. helped with the study design, and has led the Health Worker Cohort Study as its Principal Investigator. All authors have approved the final version of this manuscript to be published, have made critical comments during the preparation of the manuscript, and fully accept responsibility for this study.

Supplementary material

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Abstract

Meals are an important source of food intake, contributing to body weight and health status. Previous studies have examined the relationship between isolated mealtime behaviours and the metabolic syndrome (MetS). The aim of this study was to examine the influence over time of ten interrelated mealtime habits on the risk of developing the MetS and insulin resistance (IR) among Mexican adults. We conducted a prospective cohort study with a sample of 956 health workers. The Mealtime Habits Quality (MHQ) scale is based on four mealtime situations (availability of time to eat, distractions while eating, environmental and social context of eating, and familiar or cultural eating habits), which were used to assess the participants' MHQ at the baseline (2004–2006) and follow-up (2010–2012) evaluations. The MetS was assessed using criteria from the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) and the International Diabetes Federation (IDF). IR was defined using the homeostasis model assessment. Crude and adjusted relative risks were calculated to estimate the relationship between MHQ and the risk of developing the MetS or IR. Participants classified in the lower MHQ category had an 8.8 (95 % CI 3.1, 25) and 11.1 (95% CI 3.4, 36.1) times greater risk of developing the MetS (using the NCEP-ATP III and IDF criteria, respectively), and an 11.2 times (95% CI 3.9, 31.5) greater likelihood of developing IR, compared with those in the higher MHQ group. This prospective study reveals that individuals who engaged in more undesirable than recommended mealtime behaviours had a >10-fold risk of developing the MetS or IR.

Keywords

Mealtime habits; Metabolic syndrome; Insulin resistance; Abdominal obesity; Mexican adults

The metabolic syndrome (MetS) is a cluster of interconnected physiological, biochemical, clinical and metabolic factors that directly increase the risk of atherosclerotic cardiovascular disease (CVD), type 2 diabetes mellitus and all-cause mortality⁽¹⁾. The prevalence of the MetS is increasing worldwide along with obesity, sedentary behaviours, population ageing and unhealthy dietary habits, which include a high intake of simple carbohydrates and foods with high saturated fat along with a low intake of fibre⁽²⁾.

Nutrition research has traditionally focused on examining specific foods, nutrients and dietary components, without taking into account the context of food consumption. Since most foods are consumed as part of a meal, the social and environmental circumstances at mealtime have become key issues to better understand food intake⁽³⁾ and its influence on body weight and health status^(4,5). Some studies have shown that what people do while eating and the environmental context at mealtime can influence what people eat and their body weight^(4–6). For example, eating while distracted by watching television (TV), reading, working, listening to a detective story or music, or playing video games has been linked to increased food consumption, a higher intake of fat, fast foods and soft drinks, and a lower intake of fruits and vegetables, which can lead to a greater likelihood of becoming

overweight^(7–12). Social interactions such as eating with friends and colleagues can also be important distractions that put individuals at risk of mindless eating, increasing energy intake and weight gain^(13–15). Eating with family, however, has been shown to have potential benefits because families frequently have healthier eating habits^(16,17).

Eating out and not having enough time to eat are mealtime habits that affect food intake and body weight. For instance, rushing meals has been associated with a higher consumption of soft drinks, fast food and fat as well as with a lower intake of healthy foods⁽¹⁸⁾. Skipping breakfast has been shown to increase obesity, fasting blood insulin, and cholesterol levels^(19,20), whereas eating out has been linked with an unhealthy diet, high fat intake⁽²¹⁾, low fruit and vegetable consumption⁽²²⁾ and high risk of obesity⁽²³⁾. One's eating environment, which includes the general atmosphere, social context and the presence of distractors, is also related to diet and body weight, because it can inhibit the monitoring of food intake⁽¹³⁾, regardless of the hunger or energy needs of the individual^(7,24,25).

Recent studies have demonstrated that some mealtime behaviours can predict risk of MetS and its components. A longitudinal study of Japanese adults found that eating speed was significantly correlated with the MetS, abdominal obesity, and low levels of HDL-cholesterol⁽²⁶⁾, whereas a cross-sectional study reported that eating quickly was associated with the MetS and abdominal obesity in Japanese people⁽²⁷⁾. A population-based, cross-sectional study of Australian adults showed that eating distractions such as extensive TV watching and consuming a large amount of snack foods were associated with the MetS⁽¹⁰⁾.

Mealtime habits are of interest because they may help elucidate how familiar, social and environmental factors can influence energy intake, and consequently the development of metabolic diseases⁽⁵⁾. For example, a systematic review of intervention trials that examined the association between overall European dietary patterns and their relationship with the MetS showed that westernised dietary patterns were linked to a higher risk of the MetS while traditional patterns were inversely related⁽²⁸⁾. The Mealtime Habits Quality (MHQ) scale is based on four mealtime situations (availability of time to eat, distractions while eating, environmental and social contexts of eating, and familiar or cultural eating habits). Studies conducted with the Health Worker Cohort Study (HWCS) participants in Mexico using the MHQ scale have demonstrated that certain mealtime habits can influence food intake⁽⁴⁾, dietary patterns, obesity, and risk of weight gain⁽⁵⁾. However, few studies have prospectively evaluated the influence of specific mealtime habits on key metabolic health indicators^(5,10). The aim of this study was to investigate the relationship between the MHQ scale and risk of developing the MetS or insulin resistance (IR) among the HWCS participants at the baseline (2004–2006) and follow-up (2010–2012) evaluations.

Methods

Study population

The HWCS is a prospective cohort study composed of 1640 active and retired health workers aged 20–70 years, from the Instituto Mexicano del Seguro Social (IMSS) and the Instituto Nacional de Salud Pública, both located in Cuernavaca, Morelos. Participants were initially enrolled in a baseline assessment that occurred during 2004–2006 and were

followed-up from 2010 to 2012⁽²⁹⁾. We excluded individuals who did not complete all the mealtime habits questions in both data collection periods (n 588), participants without clinical or anthropometric assessments (n 30) and those with diseases or health conditions that could be related to weight change or mealtime habits in either data collection period, such as CVD (n 13), cancer (n 31), kidney failure (n 13) and pregnancy (n 9). The remaining 956 participants (239 men and 717 women) were included in the analysis. This study was conducted in accordance with the Helsinki declaration on human studies⁽³⁰⁾, and each participant signed an informed consent form before enrollment. The IMSS ethics committee approved the study protocol and informed consent form.

Assessment of Mealtime Habits Quality

The MHQ scale was used to assess the quality of mealtime habits among the HWCS participants by obtaining information about structured meals at any given time of the day, on any day of the week, without accounting for snacking. Mealtime items were categorised into two groups, recommended and undesirable for good health, on the basis of previously published studies^(4,5). At the baseline assessment, participants were asked 'When you eat, what do you generally do?', and they responded about their mealtime habits with the specific binary choices: 'yes' or 'no'. For the follow-up evaluation, the MHQ scale was changed to a multiple-choice response format, in order to capture a wider range of mealtime habits⁽³¹⁾. The two formats of the MHQ scale were constructed using the same domain content, and the consistency of the results of the two versions was measured through parallel-form reliability, which is reported elsewhere⁽⁵⁾.

For this study, mealtime behaviours were classified into four specific situations: (a) availability of time to eat, (b) distractions while eating, (c) environmental and social context of eating, and (d) familiar or cultural eating habits. Availability of time to eat was measured with four items at the baseline assessment ('I take my time to finish my meal', 'I rush my meals to avoid exceeding the available time to eat', 'I eat in huge mouthfuls' and 'I eat slowly'). For the follow-up assessment, these items were replaced with two questions: 'How fast do you eat your meals?' and 'Did you skip any meal?', since these questions have previously been associated with a lack of time to eat⁽³²⁾. Distractions while eating were determined using two items at the baseline assessment ('I'm distracted: I talk, watch TV or read' and 'I take advantage of mealtimes to accomplish work activities'). These two items were combined into one question for the follow-up assessment: 'Are you distracted when you eat, either by watching TV, working, reading, talking, or solving everyday problems?'. The environmental and social context of eating was measured with two items at the follow-up assessment: 'Do you eat with friends, family, or colleges?' and 'How many times per week do you eat your main meal at home?'. Familiar or cultural eating habits were assessed at baseline with the item 'I eat all my food, without leaving anything on the plate', which at follow-up was changed to 'Do you eat all your food without leaving anything on the plate?'. Moreover, food selection is a mealtime situation that has been closely related to energy intake and BMI. In this study, it was measured at baseline with the item 'I choose what I eat'; however, in order to be more specific about the type and amount of food selected by participants, this item became two questions for the follow-up assessment: 'Do you choose the food you eat with your health in mind?' and 'Do you choose the amount of food that you

eat?'. Finally, the question 'Do you enjoy eating?' was added at the follow-up assessment, because greater pleasure with food has been associated with fewer food anxieties, fewer dieting behaviours, and a lower BMI⁽⁵⁾.

Exploratory factor analysis was used for both assessments to uncover underlying factors and factor loadings. During both evaluations (2004–2006 and 2010–2012), factor solution was composed of one factor, recommended mealtime habits were correlated positively and undesirable habits had a negative correlation. The scale was constructed by summing the contribution of each item, weighted by its factor loading. As the indicators had negative values, five was added to the total summarised score in order to obtain a positive score. Each participant received an individual score representing the quality of their mealtime habits, with higher scores reflecting a better quality of mealtime habits. At baseline, the MHQ scale had a mean of 5.28 points, ranging from 2.24 to 8.08 (SD 1.17), and the internal consistency was 0.84⁽⁴⁾. During the follow-up assessment, the MHQ scale had a mean of 3.84 points with a range from 0.87 to 7.19 (SD 0.96), and the internal consistency was 0.60 (online supplementary Appendix: MHQ questionnaire form)⁽⁵⁾. A panel of data for longitudinal analysis that included the two MHQ scores was created in order to derive a personal-level data set. Next, participants were classified into tertiles (with the highest tertile reflecting the recommended MHQ), and were designated a MHQ status for baseline and another one for follow-up, so we could relate MHQ status with its corresponding MetS and IR status at baseline or follow-up.

Metabolic syndrome assessment

The Mets was determined using criteria from the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) and the International Diabetes Federation (IDF). The NCEP-ATP III defines the Mets as having at least three of the following five components: (1) abdominal obesity (waist circumference 102 cm for men and 88 cm for women), (2) elevated TAG (150 mg/dl or 1.7 mmol/l) or specific treatment for this lipid abnormality, (3) reduced HDL-cholesterol (<40 mg/dl or 1.03 mmol/l for men and <50 mg/dl or 1.29 mmol/l for women) or taking medication for this condition, (4) elevated blood pressure (systolic 130mmHg or diastolic 85mmHg) or taking medication for hypertension, or (5) elevated fasting plasma glucose (110 mg/dl or 6.1 mmol/l) or previously diagnosed type 2 diabetes⁽³³⁾.

According to the IDF definition of the Mets, a person must have abdominal obesity (90 cm for men and 80 cm for women, these cut-offs may vary based on ethnicity-specific values) or a BMI >30 kg/m² and any two of the following four factors: (1) elevated TAG (150 mg/dl or 1.7 mmol/l) or specific treatment for this lipid abnormality, (2) reduced HDL-cholesterol (<40 mg/dl or 1.03 mmol/l for men and <50 mg/dl or 1.29 mmol/l for women) or specific treatment for this lipid abnormality, (3) elevated blood pressure (systolic 130mmHg or diastolic 85 mmHg, or treatment for hypertension, or (4) elevated fasting plasma glucose (100 mg/dl or 5.6 mmol/l) or previously diagnosed type 2 diabetes⁽³⁴⁾.

Anthropometric and clinical evaluation

Waist circumference was obtained using a steel measuring tape at the high point of the iliac crest at the end of normal expiration, to the nearest 0.1 cm. Weight was assessed with participants wearing minimal clothing with a previously calibrated electronic total body composition analyser, TANITA scale, model TBF-300A. Height was measured with a conventional stadiometer. BMI was calculated as a ratio of weight (kg):height squared (m²). One blood pressure measurement was taken with an electronic digital blood pressure monitor. Participants were seated with their right arm resting at heart level. The anthropometric and blood pressure measures were obtained by nurses trained in these standardised procedures, and reproducibility of the values was evaluated (resulting in a concordance coefficient of 0.83–0.90).

Biochemical assessment

Fasting venous blood samples were collected and glucose levels were assessed by the oxidised glucose method. TAG were determined by the colorimetric method after enzymatic hydrolysis with lipases technique, HDL-cholesterol was measured by the elimination of chylomicron and subsequent catalase, and insulin sensitivity was measured using the homoeostasis model assessment and calculated from the fasting insulin and glucose measurements using the standard formula: (glucose (mmol/l) × insulin (μU/ml))/22.5⁽³⁵⁾. All biomedical assays were performed at the IMSS laboratory in Cuernavaca, Mexico, in compliance with the procedures of the International Federation of Clinical Chemistry and Laboratory Medicine⁽³⁶⁾

Demographic characteristics, smoking, energy content, and dietary patterns assessment

Demographic data were obtained through self-administered questionnaires. Smoking status was assessed using the categories proposed by the World Health Organization⁽³⁷⁾: current, past and never.

Dietary patterns (DP) and energy intake were obtained using a semi-quantitative FFQ validated in a Mexican population⁽³⁸⁾. This questionnaire included data on the consumption of 116 food items commonly consumed over the past year, ranging from never to 6 times/d. For this study, we used three major DP that were previously identified in a cross-sectional study of 9467 Mexican adults who participated in the HWCS⁽³⁹⁾. Briefly, in both assessments, food items were classified into twenty-eight food groups on the basis of similarity in nutrients, lipid content profile, sugar content, proportion of dietary fibre and commonly consumed foods. Three DP were derived: the prudent or balanced diet is represented by a greater intake of processed vegetable juices, potatoes, fresh fruits, fresh vegetables and legumes and a lower intake of pastries; the Western diet is characterised by a higher intake of pastries, refined cereals, corn tortillas and soft drinks and a lower intake of wholegrain cereals, sea food and full-fat dairy products; and the high-animal protein/high-fat diet is typified by a greater intake of red meat, processed meat, margarine and eggs and a lower intake of fruits and wholegrain cereals. The factor score for each dietary pattern was constructed by summing the standardised percentage of energy intake of food groups, weighted by their factor loading. Next, a panel of data for longitudinal analysis was created, obtaining a personal-level data set of the three DP for both assessments. Individuals were

classified into tertiles, with the highest tertile reflecting greater adherence to each DP. We then determined whether there were any differences in the participant's adherence to each DP between the baseline and follow-up assessments, and the associated risk of developing the MetS or IR over time.

Depression evaluation

Depressive symptoms were assessed using a Spanish-language depression scale, derived from a twenty-item questionnaire created by the Center for Epidemiologic Studies⁽⁴⁰⁾. We defined probable clinical depression using the mean plus one standard deviation as a cut-off, which has previously been used to identify depressive symptoms in a Mexican population⁽²⁹⁾. A continuous scale from 0 to 60 points was generated, and a score of 16 or more was used to identify participants who had depressive symptoms at the baseline or follow-up assessments⁽⁴⁰⁾.

Physical activity

Recreational physical activity (PA) was assessed using a PA questionnaire⁽⁴¹⁾ that has been validated in Spanish⁽⁴²⁾ and adapted for the HWCS population in Mexico⁽⁴³⁾. We determined PA levels on the basis of the public health recommendations regarding the type and amount of PA needed to improve and maintain health benefits among adults: <30 and 30 min/d⁽⁴⁴⁾.

Statistical analysis

The differences observed between the 2004–2006 and 2010–2012 assessments, with regard to demographics, lifestyle and anthropometric measures, prevalence of the MetS and its components as well as the prevalence of IR, were obtained using the McNemar test for assessing differences in two paired proportions and the *t* test for assessing differences in two paired means (Table 1).

The MHQ scale was constructed by summing the factor loadings of each mealtime habits item, and participants were assigned an individual MHQ score at baseline and another for the follow-up assessment. A panel of data for longitudinal analysis was then created, which included the two MHQ scores for obtaining a personal-level data set⁽⁴⁵⁾. Participants were classified into tertiles (with the highest tertile reflecting the recommended MHQ), obtaining one MHQ status for baseline and another for follow-up, so we could relate MHQ status with its corresponding MetS and IR status at baseline or follow-up. Adherence to each DP across the MHQ categories was assessed using the Cochran's *Q* test to determine whether there was a difference between the means of the three groups (Table 2). The Cochran's *Q* test was also used to identify any differences in the percentage of new cases of the MetS, components of the MetS, and IR across the three MHQ categories. For this analysis, we only included participants who did not have the MetS or its components or IR at the baseline evaluation, as defined by NCEP-ATP III or IDF criteria (Table 3).

Finally, in order to estimate the independent effect of MHQ on the risk of developing the MetS, components of the MetS, or IR over the study period, we used generalised linear models to calculate the adjusted relative risks with binomial log-linear regression⁽⁴⁶⁾, as

well as their respective 95 % CI. Relative risks were adjusted by sex, depression, dietary patterns, PA and education level as categorical variables, while age and energy intake were continuous variables. Analyses were performed using STATA software, version 12.0.

Results

Table 1 compares the demographic, anthropometric, and lifestyle characteristics of the HWCS participants from the baseline and follow-up assessments. Participants were mainly women (75%) and middle-aged, with a mean age of 46 years at baseline and 53 years at follow-up. Some anthropometric indicators and the MetS components significantly changed from 2004–2006 to 2010–2012, for example, the percentage of participants with normal BMI decreased from 38 to 33 %, whereas abdominal obesity increased from 48 to 58 % (using the NCEP-ATP III criteria) and from 80 to 88 % (using the IDF criteria). Furthermore, the percentage of participants with elevated glucose increased from 23 to 43 %, elevated TAG rose from nearly 43 to 55%, the percentage of participants with low HDL-cholesterol decreased from 88% to almost 62% and high blood pressure increased from nearly 30 % to almost 49 %. Our findings regarding the MHQ reported at baseline and during the follow-up assessment indicate that the mean score decreased significantly from 5.28 to 3.84 points. Additionally, the percentage of participants categorised in the lower MHQ category increased significantly from nearly 15 to 52%, and the percentage of participants in the higher MHQ category decreased from 58 to 8% ($P < 0.000$, for both). In terms of lifestyle characteristics, the percentage of physically active participants decreased from almost 37 to 31 %, and the prevalence of current smokers decreased from nearly 16 % to almost 11 % (Table 1).

The participants' adherence to the three DP that were identified in the HWCS population⁽³⁹⁾ was examined for each of the MHQ categories over the 7 years of follow-up, and is presented in Table 2. A higher percentage of participants with greater adherence to the balanced dietary pattern were classified in the higher MHQ category than in the lower MHQ category (40.2 v. 24.6% respectively, $P = 0.000$), whereas a greater percentage of participants adhering to the Western dietary pattern were categorised in the lower MHQ than in the higher MHQ category (37.4 v. 30.2%, respectively, $P = 0.025$). A greater percentage of participants with lower adherence to the high-protein/high-fat dietary pattern were classified in the higher MHQ than in the lower MHQ category (35.3 v. 29.4%, respectively, $P = 0.040$).

Table 3 shows that a larger percentage of participants who reported more undesirable than recommended mealtime habits during the study period developed the MetS and its components, as well as IR. During the 7-year follow-up period, 25.8 and 48.3 % of individuals in the lower MHQ category developed abdominal obesity (according to NCEP-ATP III and IDF criteria, respectively), whereas only 2.5 and 5.4% of those in the higher MHQ category developed abdominal obesity (according to NCEP-ATP III and IDF criteria, respectively). Furthermore, a greater percentage of participants in the lower MHQ category as compared with the higher MHQ category developed impaired fasting glucose (25.7 v. 3.4%), elevated TAG (30.9 v. 2.6%), decreased HDL-cholesterol (15.1 v. 0%) and high blood pressure (28.5 v. 4.3%). More participants categorised in the lower MHQ developed the MetS, 17.4 % according to the NCEP-ATP III and 20.5 % according to the IDF criteria,

compared with only 1.6 and 1.8% of those categorised in the higher MHQ, respectively. In addition, 12.5% of the participants who were classified in the lower MHQ developed IR during the study period, compared with only 1.2% of those categorised in the higher MHQ category.

The crude and adjusted relative risks for developing the MetS, its components or IR for each of the MHQ categories are presented in Table 4. Compared with participants in the higher MHQ category, those in the middle and lower MHQ categories had a 3.8 and 7.9 times greater risk of developing elevated glucose, respectively; 8.9 and 12.9 times higher risk of developing elevated TAG, respectively; were 6.0 and 9.5 times more likely to develop hypertension, respectively; had a 7.6 and 10.2 greater likelihood of developing abdominal obesity, respectively (considering the NCEP-ATP III criteria); an 8.5 and 9.8 higher risk of abdominal obesity, respectively (considering the IDF criteria); 7.3 and 8.8 times larger risk of developing the MetS, respectively (based on the NCEP-ATP III criteria); 10.9 and 11.1 times higher risk of developing the MetS, respectively (using the IDF criteria); and a 4.7 and 11.2 times greater risk of developing IR, respectively.

Discussion

The results of this prospective study indicate that certain habitual mealtime behaviours can predict the development of metabolic diseases. We found that participants who reported more undesirable mealtime habits (low MHQ) than recommended mealtime habits (high MHQ) had a > 11-fold higher risk of developing the MetS or IR. Recent nutrition studies have indicated that isolated mealtime behaviours such as distractions while eating⁽⁷⁻¹²⁾, not having enough time to eat⁽¹⁸⁾, skipping breakfast^(19,20), rushing meals, eating out⁽²¹⁾, eating quickly, and certain eating environments or social interactions during meals⁽¹³⁻¹⁵⁾ can promote unhealthy diets and a higher BMI. These undesirable mealtime behaviours are also associated with a prolonged inflammatory state, as well as the development of IR, dyslipidemia, and the MetS⁽⁴⁷⁾.

This study demonstrates that several inter-related recommended and undesirable mealtime habits can influence dietary intake, anthropometric status and the development of metabolic diseases. However, as the set of mealtime habits we examined cannot be disaggregated, it is difficult to directly compare our results with other studies that have evaluated the influence of isolated mealtime behaviours on risk of the MetS and its components. To better understand the impact of specific mealtime habits on anthropometric indicators and the subsequent development of metabolic diseases, we situate our results in a comprehensive theoretical framework to help explain how four mealtime situations – availability of time to eat, distractions while eating, environmental and social context of eating, and familiar or cultural eating habits – can affect food intake and risk of the MetS.

We evaluated availability of time to eat through the following four items: taking time to eat, rushing meals, skipping meals, and eating in huge mouthfuls. Other researchers have also studied the effects of eating quickly on risk of developing the MetS. For example, a longitudinal study with Japanese adults found that compared with the slow-eating group, the fast-eating group had a multivariate-adjusted hazard ratio that was 1.30 times greater

for incidence of the MetS, 1.35 times higher for abdominal obesity, and 1.37 times greater for low HDL-cholesterol⁽²⁶⁾. In a cross-sectional study of Japanese adults, the likelihood of having the MetS was inversely related to eating speed – 0.79 for slow and 1.61 for fast eating among men ($P < 0.001$) and 0.74 for slow and 1.27 for fast eating among women ($P < 0.001$) – and eating rate was also associated with abdominal obesity⁽²⁷⁾. Lack of time to eat is a frequent trend in many countries, for example, among young adults in the USA, 35 % of males and 42 % of females reported not having enough time to sit down and eat a meal. Eating on the run is associated with a higher intake of soft drinks, fast food and fat, as well as a lower intake of healthy foods among females⁽¹⁸⁾. Among a sample of university employees in central Mexico, 39 % reported a lack of time to eat breakfast at home and 13 % indicated that they eat street food. In some urban environments and workplaces in Mexico, it may be difficult to find healthy food options because many restaurants mostly offer fatty foods, sweetened soft drinks and, meals that lack fruits and vegetables⁽⁴⁸⁾.

We analysed two items that relate to distractions while eating: watching TV or reading while eating and doing office work while eating. Distractions while eating have received much attention as they have been associated with ignoring satiety signals that trigger feelings of fullness⁽⁴⁹⁾, which impairs the ability to monitor food consumption, leading to an unintentional excess of energy intake⁽⁵⁰⁾. Other studies have evaluated the impact of eating distractions on the MetS risk, including a cross-sectional study of 5682 Australian adults over the age of 35 years. They found that participants who spent 2 h/d watching TV and consumed three or more snack food servings per day were 1.5 and 3.6 times more likely to have the MetS, respectively, compared with those who reported low levels of TV viewing and low snack intake⁽¹⁰⁾. Poor dietary habits are potential mediators associated with high levels of TV viewing that can be triggered by advertising^(51,52) and increased intake of energy-dense and nutrient-poor snack foods⁽⁵³⁾. TV viewing has also been shown to have an impact on subsequent meals because individuals who eat while watching TV report less vivid memories of their previous meals and consequently consume more food at the subsequent meals⁽⁷⁾. A meta-analysis of twenty-four experimental studies provided additional evidence that watching TV reduces attention during eating, which increases food intake at the next meal⁽⁹⁾. In the present study, we also examined other distractions such as reading, doing office work or engaging in tasks, which have been demonstrated to be associated with a greater likelihood of becoming overweight/obese^(8–12,50). Other sources of distractions examined by the scientific literature are listening to stories or music, playing video games, social interactions, and eating environment, which can all lead to impaired awareness of food consumption, mindless eating, increased energy intake, and risk of weight gain^(8,13–15). The environmental and social contexts of eating were also assessed as part of the current study by taking into account the number of times participants ate with friends, family or colleagues, and the number of times they ate their main meal at home. One's eating environment, which includes social interactions and distractions, can make people more vulnerable to mindless eating, resulting in increased meal size and energy intake⁽¹³⁾, regardless of hunger^(7,24,25). Other studies have shown that meals eaten with others tend to be larger and longer in duration compared with meals eaten alone, regardless of the relationship of the eating companion or the time of day, with similar effects occurring at morning, noontime and evening meals⁽²⁵⁾. Furthermore, a systematic review of twenty-nine

nationally representative studies or large cohorts reported that eating away from home is associated with a higher total energy intake, energy content from fat and lower intake of micronutrients, particularly vitamin C, Ca and Fe⁽²¹⁾.

The familiar and cultural customs associated with eating were also examined using the following three items: eating with family, friends or colleagues, eating at home, and eating all the food without leaving anything on the plate. The scientific literature provides evidence that culture is one of the major determinants of what we eat, reflecting unwritten social rules such as eating all the food one is served, which is usually done to show appreciation for the food⁽⁴⁹⁾. However, due to the enormous serving sizes that are offered at restaurants, this custom has become an unhealthy habit that contributes to overeating⁽⁵⁴⁾. Furthermore, the largest contributors to both adult and child BMI seem to include the familiar mealtime habits of the people with whom one eats, as well as the location and duration of the meals⁽¹⁷⁾.

The results of this prospective study suggest that individuals who are engaged in more undesirable than recommended mealtime behaviours have a >10-fold risk of developing the MetS or IR. Other observational studies report an inverse relationship between the MetS and a greater adherence to healthy diets, such as the Mediterranean diet, 'Dietary Approach to Stop Hypertension' or diets based on guidelines such as the 'Healthy Eating Index' in the USA or the 'Programme National Nutrition Santé' in France^(3,28,49-51). A prospective study with 3232 participants from a large European cohort demonstrated that higher adherence to a Mediterranean diet reduced risk of the MetS to 0.47 (95% CI 0.32, 0.69) and 0.50 (95% CI 0.32, 0.77) using the updated Mediterranean score and the Mediterranean Diet Score, respectively⁽⁵⁵⁾. A systematic review of intervention trials that focused on European Dietary Patterns and the MetS showed that the Western dietary pattern, which includes high servings of saturated fatty acids and simple carbohydrates, is associated with a higher risk of the MetS. Conversely, more traditional dietary patterns that are characterised by a high intake of vegetables, fruits, wholegrain cereals and fish are associated with a reduced risk of the MetS⁽²⁸⁾.

Other studies with the HWCS participants have shown that the quality of mealtime habits is associated with dietary patterns^(4,5). A cross-sectional study of 5240 HWCS participants between the ages of 20 and 70 years found that a Western dietary pattern that includes a high intake of pastries, refined cereals, corn tortillas and soft drinks, as well as a lower intake of wholegrain cereals, sea food and full-fat dairy products, is associated with a significantly greater risk of high fasting glucose (OR 1.67), low HDL-cholesterol (OR 1.55) and the MetS (OR 1.56)⁽³⁹⁾. A longitudinal study of 837 HWCS participants reported that the healthiest MHQ category is related to a greater adherence to the balanced dietary pattern (higher intake of fresh fruits and vegetables, legumes and a lower intake of pastries), and a lower adherence to the protein/fat dietary pattern (greater intake of red meat, processed meat, margarine and eggs and a lower intake of fruits and wholegrain cereals). In contrast, the least healthy MHQ category is related to a higher adherence to the aforementioned Western dietary pattern⁽⁵⁾. Moreover, a cross-sectional study with 7472 HWCS participants found that individuals who were classified in the healthier MHQ category were more likely to report adherence to a balanced dietary pattern than to the Western pattern⁽⁴⁾.

The MHQ scale was constructed with self-reported mealtime behaviours, which might not capture all possible variations at mealtime. Since food intake is affected by the meal of the day, the day of the week, the specific eating context, and the people who are present, we believe that using the MHQ scale to assess mealtime habits has several benefits. First, the MHQ scale is a tool that generalises people's daily life experiences regarding meals, attempting to provide a general picture of mealtime habits. Second, the original MHQ scale was composed of binary response items for the baseline assessment, which were changed to multiple-choice responses for the follow-up assessment, allowing for a wider variety of possible mealtime behaviours to be studied. Third, the MHQ scale has been demonstrated to be a comprehensive, reliable and valid instrument because of its structure, its ability to predict dietary patterns, body weight status and the MetS, as well as its demonstrated consistency with other Mexican populations, including adolescents⁽⁴⁻⁶⁾

Conclusions

In previous studies, the quality of mealtime habits has demonstrated the ability to predict dietary patterns, anthropometric status, and risk of gaining weight^(4,5). The present study provides evidence that certain meal situations such as availability of time to eat, distractions while eating, the environmental and social contexts of eating, and familiar or cultural eating habits are associated with the development of the MetS and/or IR. Our results also support the idea that mealtime habits could be a key issue in nutrition research, since most foods are consumed as part of a meal, making the meal an appropriate area of study for concerns about food intake and its consequences on health⁽³⁾. Moreover, the MHQ scale could be used as a part of health promotion interventions that target mealtime behaviours, in order to help demonstrate how these strategies could improve diet quality, thus reducing the risk of weight gain and metabolic diseases.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations:

DP	dietary patterns
HWCS	Health Worker Cohort Study
IDF	International Diabetes Federation
IR	insulin resistance
MetS	metabolic syndrome

MHQ	Mealtime Habits Quality
NCEP-ATP III	National Cholesterol Education Program Adult Treatment Panel III
TV	television

References

1. Kaur J (2014) A comprehensive review syndrome. *Cardiol Res Pract* 2014, 943162.
2. Pitsavos C, Panagiotakos D, Weinem M, et al. (2006) Diet, exercise and the metabolic syndrome. *Rev Diabet Stud* 3, 118–126. [PubMed: 17487335]
3. Meiselman HL (2009) *Meals in Science and Practice: Interdisciplinary Research and Business Applications*. Woodhead Publishing Series in Food Science, Technology and Nutrition no. 171. Boca Raton, FL: CRC Press LLC.
4. Dosamantes-Carrasco D, Méndez-Hernández P, Denova-Gutiérrez E, et al. (2011) Scale for assessing the quality of Mexican adults' mealtime habits. *Salud Publica Mex* 53, 152–159. [PubMed: 21537806]
5. Dosamantes-Carrasco D, Méndez-Hernández P, Flores YN, et al. (2016) Influence of mealtime habits on the risk of weight gain and obesity in Mexican adults. *Public Health Nutr* (in the Press).
6. Pierlot R (2016) Estudio sobre la promoción de un estilo de vida saludable en jóvenes de bachillerato de Ixtenco, Tlaxcala, México (Research on the promotion of a healthy lifestyle in high schoolers from Ixtenco, Tlaxcala, Mexico). PhD Thesis, Universidad Autónoma de Tlaxcala.
7. Bellisle F, Dalix AM & Slama G (2004) Non food-related environmental stimuli induce increased meal intake in healthy women: comparison of television viewing versus listening to a recorded story in laboratory settings. *Appetite* 43, 175–180. [PubMed: 15458803]
8. Ogden J, Coop N, Cousins C, et al. (2013) Distraction, the desire to eat and food intake. Towards an expanded model of mindless eating. *Appetite* 62, 119–126. [PubMed: 23219989]
9. Robinson E, Aveyard P, Daley A, et al. (2013) Eating attentively: a systematic review and meta-analysis of the effect of food intake memory and awareness on eating. *Am J Clin Nutr* 9, 728–742.
10. Thorp AA, McNaughton SA, Owen N, et al. (2013) Independent and joint associations of TV viewing time and snack food consumption with the metabolic syndrome and its components; a cross-sectional study in Australian adults. *Int J Behav Nutr Phys Act* 9, 10–96.
11. Long S, Meyer C, Leung N, et al. (2011) Effects of distraction and focused attention on actual and perceived food intake in females with non-clinical eating psychopathology. *Appetite* 56, 350–356. [PubMed: 21185894]
12. Higgs S & Woodward M (2009) Television watching during lunch increases afternoon snack intake of young women. *Appetite* 52, 39–43. [PubMed: 18692103]
13. Wansink B (2004) Environmental factors that increase the food intake and consumption volume of unknowing consumers. *Annu Rev Nutr* 24, 455–579. [PubMed: 15189128]
14. Martínez-Díaz DJ (2009) Valores y creencias en el consumo de comidas en los hogares barraquilleros (Values and beliefs in Barranquilleros households' food consumption). *Pensamiento Gestión* 27, 1–58.
15. Raulio S, Roos E, Mukala K, et al. (2008) Can working conditions explain differences in eating patterns during working hours? *Public Health Nutr* 11, 258–270. [PubMed: 17610750]
16. Orrell-Valente JK, Hill LG, Brechwald WA, et al. (2007) Just three more bites: an observational analysis of parents' socialization of children's eating at mealtime. *Appetite* 48, 37–45. [PubMed: 17000028]
17. Anderson EN (2005) *Everyone Eats: Understanding Food and Culture*. New York and London: New York University Press, Library of Congress Cataloging-in-Publication Data.
18. Larson NI, Nelson MC, Neumark-Sztainer D, et al. (2009) Making time for meals: meal structure and associations with dietary intake in young adults. *J Am Diet Assoc* 109, 72–79. [PubMed: 19103325]

19. Smith KJ, Gall SL, McNaughton SA, et al. (2010) Skipping breakfast: longitudinal associations with cardiometabolic risk factors in the childhood determinants of adult health study. *Am J Clin Nutr* 92, 1316–1325. [PubMed: 20926520]
20. Timlin MT. & Pereira MA (2007) Breakfast frequency and quality in the etiology of adult obesity and chronic diseases. *Nutr Rev* 65, 268–281. [PubMed: 17605303]
21. Lachat C, Nago E, Verstraeten R, et al. (2012) Eating out of home and its association with dietary intake: a systematic review of the evidence. *Obes Rev* 13, 329–346. [PubMed: 22106948]
22. Crawford D, Ball K, Mishra G, et al. (2007) Which food-related behaviors are associated with healthier intakes of fruits and vegetables among women??. *Public Health Nutr* 10, 256–265. [PubMed: 17288623]
23. Kruger J, Blanck HM & Gillespie C (2008) Dietary practices, dining out behavior and physical activity correlates of weight loss maintenance. *Prev Chronic Dis* 5, 1–14.
24. Bellisle F, Dalix AM, Airinei G, et al. (2009) Influence of dietary restraint and environmental factors on meal size in normal-weight women. A laboratory study. *Appetite* 53, 309–313. [PubMed: 19619596]
25. De Castro JM (1994) Family and friends produce greater social facilitation of food intake than other companions. *Physiol Behav* 56, 445–445. [PubMed: 7972393]
26. Zhu B, Haruyama Y, Muto T, et al. (2015) Association between eating speed and metabolic syndrome in a three-year population-based cohort study. *J Epidemiol* 25, 332–336. [PubMed: 25787239]
27. Nagahama S, Kurotani K, Pham NM, et al. (2014) Self-reported eating rate and metabolic syndrome in Japanese people: cross-sectional study. *BMJ Open* 4, e005241.
28. Martínez-González MÁ & Martín-Calvo N (2013) The major European dietary patterns and metabolic syndrome. *Rev Endocr Metab Disord* 14, 265–271. [PubMed: 23979531]
29. Gallegos-Carrillo K, Flores YN, Denova-Gutiérrez E, et al. (2013) Physical activity and reduced risk of depression: results of a longitudinal study of Mexican adults. *Health Psychol* 32, 609–615. [PubMed: 22946463]
30. Council for International Organizations of Medical Sciences & World Health Organization (1993) *International Ethical Guidelines for Biomedical Research Involving Human Subjects*. Geneva: Council for International Organizations of Medical Sciences (CIOMS).
31. Spector P (1992) *Summated Rating Scale Construction*, 1st ed. Iowa City, IA: University of Iowa.
32. Goon S & Islam S (2014) Breakfast skipping and obesity risk among urban adults in Bangladesh. *Int J Public Health Science* 3, 15–22.
33. Grundy SM, Cleeman JI, Daniels SR, et al. (2005) Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement. *Circulation* 112, 2735–2752. [PubMed: 16157765]
34. Zimmet P, Alberti KGMM & Serrano-Ríos M (2006) A new International Diabetes Federation worldwide definition of the metabolic syndrome: the rationale and the results. *Rev Esp Cardiol* 59, 185.
35. Matthews DR, Hosker JP, Rudenski AS, et al. (1985) Homeostasis model assessment: insulin resistance and b-cell function from fasting plasma glucose and insulin concentrations in man. *Diabetologia* 28, 412–419. [PubMed: 3899825]
36. Tate JR, Berg K, Courderc R, et al. (1999) International federation of clinical chemistry and laboratory medicine (IFCC) standardization project for the measurement of lipoprotein(a). Phase 2: selection and properties of a proposed secondary reference material for lipoprotein(a). *Clin Chem Lab Med* 37, 949–958. [PubMed: 10616748]
37. World Health Organization (1997) *Tobacco or Health: A Global Status Report*. Geneva: WHO Library. <http://www.kfshrc.edu.sa/annals/articles/182/Bookrev182.pdf>
38. Hernández-Avila M, Romieu I, Parra S, et al. (1998) Validity and reproducibility of a food frequency questionnaire to assess dietary intake of women living in Mexico city. *Salud Publica Mex* 40, 133–140. [PubMed: 9617194]
39. Denova-Gutiérrez E, Castañón S, Talavera JO, et al. (2010) Dietary patterns are associated with metabolic syndrome in an urban Mexican population. *J Nutr* 140, 1855–1863. [PubMed: 20702749]

40. Radloff LS (1977) The CES-D scale: a self-report depression scale for research in the general population. *Appl Psychol Meas* 1, 385–401.
41. Wolf AM, Hunter DJ, Colditz GA, et al. (1994) Reproducibility and validity of a self-administered physical activity questionnaire. *Int J Epidemiol* 23, 991–999. [PubMed: 7860180]
42. Martínez-González MA, López-Fontana C, Varo JJ, et al. (2005) Validation of the Spanish version of the physical activity questionnaire used in the Nurses' Health Study and the Health Professionals' Follow-up Study. *Public Health Nutr* 8, 920–927. [PubMed: 16277809]
43. Méndez-Hernández P, Flores Y, Siani C, et al. (2009) Physical activity and risk of metabolic syndrome in an urban Mexican cohort. *BMC Public Health* 9, 1–10. [PubMed: 19121216]
44. Fernández-García V & Hernández-Tezoquipa I (2007) Promoción de la actividad Física (Physical activity promotion). Cuernavaca, Morelos, Mexico: Instituto Nacional de Salud Pública, Secretaría de Salud.
45. Baltagi BH (2004) Panel Data. Theory and Applications. Heidelberg: Physica-Verlag.
46. Rothman KJ, Greenland S & Lash TL (2008) Modern Epidemiology, 3rd ed. Philadelphia, PA: Lippincott, Williams & Wilkins.
47. Ahluwalia N, Andreeva VA, Kesse-Guyot E, et al. (2013) Dietary patterns, inflammation and the metabolic syndrome. *Diabetes Metab* 39, 99–110. [PubMed: 23062863]
48. Méndez-Hernández P, Siani C, Lamure M, et al. (2008) Préférences déclarées sur trois programs d'activité physique pour empêcher les maladies chroniques au Mexique (Stated preferences on three programs of physical activity to prevent chronic diseases in Mexico). 9ème Conférence internationale sur la science des systèmes de santé, Nouvelles technologies de l'information et gouvernance des systèmes de santé, 3 to 5 September 2008, Lyon, p. 188.
49. Wansink B (2010) From mindless eating to mindlessly eating better. *Physiol Behav* 100, 454–463. [PubMed: 20470810]
50. Moray J, Fu A, Brill K, et al. (2007) Viewing television while eating impairs the ability to accurately estimate total amount of food consumed. *Bariatr Nurs Surg Patient Care* 2, 71–76.
51. Thompson M, Spence JC, Raine K, et al. (2008) The association of television viewing with snacking behavior and body weight of young adults. *Am J Health Promot* 22, 329–335.
52. Scully M, Dixon H. & Wakefield M (2009) Association between commercial television exposure and fast-food consumption among adults. *Public Health Nutr* 12, 105–110. [PubMed: 18339226]
53. Cleland VJ, Schmidt MD, Dwyer T, et al. (2008) Television viewing and abdominal obesity in young adults: is the association mediated by food and beverage consumption during viewing time or reduced leisure-time physical activity? *Am J Clin Nutr* 87, 1148–1155. [PubMed: 18469233]
54. Ouweland C & De Ridder DT (2008) Effects of temptation and weight on hedonics and motivation to eat in women. *Obesity* 16, 1788–1793. [PubMed: 18551110]
55. Kesse-Guyot E, Ahluwalia N, Lassale C, et al. (2013) Adherence to Mediterranean diet reduces the risk of metabolic syndrome: a 6-year prospective study. *Nutr Metab Cardiovasc Dis* 23, 677–683. [PubMed: 22633793]

Demographic, anthropometric, and lifestyle characteristics of the HWCS participants at the baseline and follow-up evaluations (*n* 956: female 717, male 239)

(Mean values and standard deviations)

Table 1.

Characteristics of the study population	Baseline		Follow-up		<i>P</i> *
	Mean	SD	Mean	SD	
Age (years)	46.3	11.5	53.3	11.5	0.000
Weight (kg)	67.4	13.4	68.4	13.8	0.000
Waist circumference in men (cm)	95.6	9.6	98.4	10.5	0.002
Waist circumference in women (cm)	90.5	12.4	92.4	11.3	0.000
BMI (kg/m ²) [†]	26.7	4.4	27.3	4.5	0.004
Normal (%)	38.2		33.3		0.000
Overweight (%)	41.5		43.7		0.176
Obesity (%)	20.2		23.0		0.005
Abdominal obesity (NCEP-ATP III definition)					
>102 cm in men and >88 cm in women (%)	48.0		58.4		0.000
Abdominal obesity (IDF definition)					
>90 cm in men and >80 cm in women (%)	80.3		88.2		0.000
Glucose (100 mg/dl) (%)	23.1		43.1		0.000
TAG (150 mg/dl) (%)	42.9		55.5		0.000
Reduced HDL (<40mg/dl men and <50mg/dl women) (%)	88.2		61.8		0.000
Blood pressure (130/85 mmHg) (%)	29.7		48.9		0.000
MetS (NCEP-ATP III definition) (%)	54.2		56.1		0.192
MetS (IDF definition) (%)	62.7		63.0		0.941
Insulin resistance (HOMA)	2.3	4.2	2.54	3.5	0.174
Insulin resistance (>3.2 HOMA) (%)	21.2	23.4	0.230		
Energy content (kJ)	9064.3	5098	7922.9	4081	
Energy content (kcal)	2165.5	1218	1892.8	975	0.000
Dietary patterns [‡]					
Balanced, greater adherence (%)	36.2		33.8		0.219

Characteristics of the study population	Baseline		Follow-up		P *
	Mean	SD	Mean	SD	
High fat/protein, greater adherence (%)	33.9		31.4		0.152
Western, greater adherence (%)	36.7		33.4		0.133
MHQ score [§]	52.8	1.17	3.84	0.96	0.000
Lower MHQ category (%)	14.9		52.4		0.000
Middle MHQ category (%)	26.9		39.3		0.001
Higher MHQ category (%)	58.2		8.3		0.000
Recreational physical activity (min/d)	25.4	30.5	22.2	27.9	0.035
Active (>30 min/d) (%)	36.7		31.3		0.006
Depression (%)	20.5		20.2		1.000
Current smoker (%)	15.9		10.8		0.000

NCEP-ATP III, National Cholesterol Education Program Adult Treatment Panel III; IDF, International Diabetes Federation; MetS, metabolic syndrome; HOMA, homeostasis model assessment; MHQ, Mealtime Habits Quality.

* P value was calculated using the McNemar test for difference in two paired proportions, and the *t* test (for paired data) to assess difference of two means, both comparing baseline and follow-up assessments. Proportions and means were adjusted by age and sex. A P value 0.05 was considered as significant.

[†] BMI: ratio of weight (kg):height squared (m²); normal weight 18.5–24.9 kg/m², overweight 25–29.9 kg/m², obesity 30 kg/m².

[‡] Dietary pattern adherence: balanced dietary pattern was typified by greater intake of processed vegetable juices, potatoes, fresh fruits, fresh vegetables and legumes and a lower intake of pastries; the Western dietary pattern was characterised by a higher intake of pastries, refined cereals, corn tortillas and soft drinks and a lower intake of wholegrain cereals, sea food and full-fat dairy products; and the high-protein/high-fat dietary pattern was typified by a greater intake of red meat, processed meat, margarine and eggs and a lower intake of fruits and wholegrain cereals. Dietary patterns were categorised in tertiles; tertile 3 represents greater adherence⁽³⁹⁾

[§] The MHQ score was created by summing factor loadings of each mealtime habits item, assigning each participant an individual MHQ score at baseline and another at the follow-up assessment. Categories of the MHQ: lower MHQ category (from 0.87 to 3.86 points score), middle MHQ category (from 3.87 to 5.19 score) and higher MHQ category (5.20 to 8.08 score).

Table 2.

Dietary pattern adherence across Mealtime Habits Quality (MHQ) categories, at baseline and follow-up evaluations, among Mexican adult participants*

Dietary pattern adherence [‡]	MHQ categories [†]			P [§]
	Low (n 321)	Middle (n 317)	High (n 318)	
Balanced dietary pattern (%)				
Tertile 1	35.9	33.3	31.0	0.192
Tertile 2	39.5	31.9	28.8	0.000
Tertile 3	24.6	34.8	40.2	0.000
Western dietary pattern (%)				
Tertile 1	31.0	35.0	34.0	0.319
Tertile 2	31.6	32.5	35.8	0.257
Tertile 3	37.4	32.5	30.2	0.025
High-protein/high-fat dietary pattern (%)				
Tertile 1	29.4	35.3	35.3	0.040
Tertile 2	35.0	33.5	31.5	0.409
Tertile 3	35.6	31.2	33.2	0.274

* Categories: lower MHQ category (from 0.87 to 3.86 points score), middle MHQ category (from 3.87 to 5.19 score) and higher MHQ category (from 5.20 to 8.08 score).

[†]The MHQ category was constructed by summing the factor loadings of each mealtime habit item, assigning each participant an individual MHQ score at baseline and another at the follow-up assessment. Individuals were classified in tertiles (highest tertile reflecting more advisable MHQ), obtaining one MHQ status for baseline and another for follow-up.

[‡]Dietary pattern adherence: balanced dietary pattern (typified by a greater intake of processed vegetable juices, potatoes, fresh fruits, fresh vegetables and legumes and a lower intake of pastries; Western dietary pattern (higher intake of pastries, refined cereals, corn tortillas and soft drinks, and a lower intake of wholegrain cereals, sea food, and full-fat dairy products); and high-protein/high-fat dietary pattern (greater intake of red meat, processed meat, margarine, and eggs and a lower intake of fruits and wholegrain cereals). Dietary patterns were categorised into tertiles; tertile 3 represents greater adherence⁽³⁹⁾.

[§]In order to relate the MHQ status to the respective baseline or follow-up dietary pattern adherence, the Cochran's *Q* test was performed to assess the difference of three probabilities. Proportions were adjusted by sex and age. A *P* value <0.05 was considered statistically significant.

Change in the percentage of participants with the metabolic syndrome (MetS) components, the MetS, and insulin resistance (IR) across Mealtime Habits Quality (MHQ) categories, after 7 years of follow-up, among the HWCS participants

Table 3.

MetS and its components, and IR	MHQ scale categories*			P †
	Low (0·87–3·86 score)	Middle (3·87–5·19 score)	High (5·20–8·08 score)	
Normal WC at baseline (<i>n</i> 497)				
Raised WC after follow-up (<i>n</i> 150) (%) (NCEP-ATP III definition: >102cm in men and >88 cm in women)	25·8	18·2	2·5	0·000
Normal WC at baseline (<i>n</i> 188)				
Raised WC after follow-up (<i>n</i> 114) (%) (IDF definition: >90cm in men and >80cm in women)	48·3	43·9	5·4	0·000
Normal glucose at baseline (<i>n</i> 735)				
Raised glucose at follow-up (<i>n</i> 220) (100 mg/dl) (%)	25·7	15·8	3·4	0·000
Normal TAG at baseline (<i>n</i> 545)				
Raised TAG at follow-up (<i>n</i> 196) (%) (150 mg/dl)	30·9	20·8	2·6	0·000
Normal HDL at baseline (<i>n</i> 113)				
Reduced HDL at follow-up (<i>n</i> 29) (%) (<40 mg/dl in men and <50 mg/dl in women)	15·1	22·1	0·0	0·000
Normal blood pressure at baseline (<i>n</i> 672)				
Raised blood pressure at follow-up (<i>n</i> 237) (%) (130/85 mmHg)	28·5	20·5	4·3	0·000
Free MetS at baseline (<i>n</i> 438)				
Developed MetS at follow-up (<i>n</i> 150) (%) (NCEP-ATP III definition)	17·4	14·4	1·6	0·000
Free MetS at baseline (<i>n</i> 356)				
Developed MetS at follow-up (<i>n</i> 93) (%) (IDF definition)	20·5	17·2	1·8	0·000
Free IR at baseline (<i>n</i> 738)				
Developed IR at follow-up (<i>n</i> 100) (%) (HOMA >3·2)	12·5	5·3	1·2	0·000

WC, waist circumference; NCEP-ATP III, National Cholesterol Education Program Adult Treatment Panel III; IDF, International Diabetes Federation; HOMA, homeostasis model assessment.

* The MHQ score was created by summing factor loadings of each mealtime habits item, assigning each participant an individual MHQ score at the baseline and another at the follow-up assessment. Categories of the MHQ: lower MHQ category (from 0·87 to 3·86 points score), middle MHQ category (from 3·87 to 5·19 score) and higher MHQ category (5·20 to 8·08 score).

† To assess the difference for developing MetS components, MetS and IR across MHQ categories, Cochran's Q test was performed to assess the difference of three probabilities. Proportions were adjusted by sex and age. A *P* value <0·05 was considered as statistically significant.

Table 4.

Developing the metabolic syndrome (MetS) and insulin resistance (IR) across the Mealtime Habits Quality (MHQ) categories, after 7 years follow-up, among Mexican adults
(Relative risks (RR) and 95 % confidence intervals)

The MetS and its components, and IR	Participants with normal values at baseline (n)	Abnormal values of the MetS and its components, and IR after follow-up (n)	Analysis	MHQ scale categories [†]					
				High		Middle		Low	
				RR	95% CI	RR	95% CI	RR	95% CI
Elevated glucose (>100mg/dl)	735	220	Crude	1	4-6 ^{***}	2-8, 7-7	7-6 ^{***}	4-6, 123	
			Adjusted	1	3-8 ^{***}	2-0, 7-1	7-9 ^{***}	4-4, 14-3	
Elevated TAG (>150mg/dl)	545	196	Crude	1	7-8 ^{***}	4-1, 14-8	11-5 ^{***}	6-1, 21-7	
			Adjusted	1	8-9 ^{***}	3-9, 20-3	12-9 ^{***}	5-8, 29-1	
Reduced HDL (<40mg/dl in men and <50mg/dl in women)	113	29	Crude	-	-	-	-	-	
			Adjusted	-	-	-	-	-	
Hypertension (>130/85 mmHg)	672	237	Crude	1	4-7 ^{***}	2-9, 7-5	6-5 ^{***}	4-1, 10-3	
			Adjusted	1	6-0 ^{***}	3-1, 11-6	9-5 ^{***}	5-1, 18-0	
Abdominal obesity (NCEP-ATP III definition) (>102 cm in men and >88 cm in women)	497	150	Crude	1	8-1 ^{***}	3-9, 16-7	11-4 ^{***}	5-6, 3-2	
			Adjusted	1	7-6 ^{***}	3-2, 17-7	10-2 ^{***}	4-5, 23-4	
Abdominal obesity (IDF definition) (>90cm in men and >80 cm in women)	188	114	Crude	1	7-8 ^{***}	4-0, 15-1	8-5 ^{***}	4-4, 16-5	
			Adjusted	1	8-5 ^{***}	3-9, 18-6	9-8 ^{***}	4-5, 20-9	
MetS (NCEP-ATP III definition)	438	150	Crude	1	9-1	3-7, 22-8	11-0 ^{***}	4-5, 27-4	
			Adjusted	1	7-3 ^{***}	2-6, 20-8	8-8	3-1, 25-0	
MetS (IDF definition)	356	93	Crude	1	10-0 ^{***}	2-1, 11-8	11-2 ^{***}	4-7, 24-6	
			Adjusted	1	10-9 ^{***}	3-3, 35-4	11-1 ^{***}	3-4, 36-1	
IR (HOMA >3.2)	738	100	Crude	1	4-9 ^{***}	2-1, 11-8	10-8 ^{***}	4-7, 24-6	
			Adjusted	1	4-7 [*]	1-6, 14-1	11-2 ^{***}	3-9, 31-5	

NCEP-ATP III, National Cholesterol Education Program Adult Treatment Panel III; MetS, metabolic syndrome; IDF, International Diabetes Federation; HOMA, homocostasis model assessment.

P values and CI of the RR were calculated by using generalised linear models, which were adjusted by sex, depression, dietary patterns (balanced, Western and high protein/fat), with recreational physical activity and level education as categorical variables and age and energy content as continuous variables.

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* $P < 0.05$,

*** $P < 0.001$.

[†]The MHQ score was created by summing factor loadings of each mealtime habits item, assigning each participant an individual MHQ score at the baseline and another at the follow-up assessment. Categories of the MHQ: lower MHQ category (from 0.87 to 3.86 points score), middle MHQ category (from 3.87 to 5.19 score) and higher MHQ category (5.20 to 8.08 score).