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Adherence to the DASH diet by hypertension status in Mexican men and women: A cross-sectional study

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ABSTRACT

Improving dietary patterns is a cornerstone of the non-pharmacological management of hypertension. Evidence about the adherence to healthy dietary patterns at the population level is scarce. We aimed to analyze the adherence to the Dietary Approaches to Stop Hypertension (DASH) diet among Mexican men and women by hypertension status. We used data from the 2012 Mexican National Health and Nutrition Survey (n = 2560). Using self-reported diagnosis of hypertension and blood pressure measurements, we identified participants without, with undiagnosed, and diagnosed hypertension. We calculated DASH scores (total and dietary components) based on a single 24-hour recall and analyzed differences in adherence across hypertension status using sex-specific multivariable Poisson regression models. Overall, regardless of hypertension status, adherence to the DASH score was low, with 35% of men and 38% of women with diagnosed hypertension adhering to recommended guidelines; lower adherence was observed in men (21.8%) and women (27.2%) with undiagnosed hypertension, and with no hypertension (26.8% in men, 26.3% in women). In multivariable models for men, the prevalence of adherence to the total DASH diet was 29% lower in undiagnosed adults versus adults without hypertension (RP 0.71; 95%CI 0.50,0.99). Specifically, adherence to fruits, total dairy, and animal protein was lower in undiagnosed men. Among women, the adherence to the DASH diet was similar across hypertension status in multivariable models. Mexican adults had low adherence to DASH, regardless of hypertension status. Strategies to improve adherence to DASH are needed, focusing in patients with hypertension but also as a preventive measure for the population.

1. Introduction

Hypertension is a major cardiovascular risk factor for death and disability (Institute for Health Metrics and Evaluation, 2015). In 2015, hypertension affected 1.1 billion people and was responsible for 21% of disability-adjusted life years and 33% of deaths (Institute for Health Metrics and Evaluation, 2015; Forouzanfar et al., 2017). In Mexico, hypertension affects 25.5% of adults. However, only 60% of them have received a medical diagnosis, leaving a large proportion of the population undiagnosed. Hypertension control remains a challenge in the country. Among people with diagnosed hypertension only 59% are under control, despite 79% are taking hypertension medication regularly (Mexican National Institute of Public Health, 2016). It was estimated in Mexico that 6 to 14% of patients with hypertension adhere to non-pharmaceutical recommendations, such as physical activity and diet (Campos-Nonato et al., 2018).

Changing dietary habits is a cornerstone of hypertension prevention and management (Whelton et al., 2018; Bakris et al., 2019). International guidelines recommend the Dietary Approaches to Stop Hypertension (DASH) diet to control blood pressure (Whelton et al., 2018; Bakris et al., 2019). The DASH diet promotes high intakes of fruits, vegetables, high fiber grains, and low-fat dairy products to increase the intake of protective nutrients and decrease sodium and saturated fats. Population studies analyzing the adherence to DASH recommendations in patients with hypertension are scarce. In the United States, different studies have shown lower levels of adherence to the DASH diet. One study reported that only 21% of individuals with hypertension complied with the DASH diet (Couch et al., 2008), while other two studies reported scores far below the maximum (between 1.8 and 6.2 for maximum scores of 9 and 10, respectively) among adults with

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hypertension (Epstein et al., 2012; Racine et al., 2011). Population estimates of DASH adherence in participants with and without hypertension are key to targeting dietary counseling, reinforcing good nutritional practices, and evaluating the population-level impact of dietary guidelines.

We aimed to analyze the prevalence of adherence to the DASH diet among Mexican men and women without hypertension, with undiagnosed hypertension, and with diagnosed hypertension using data from the 2012 Mexican National Health and Nutrition Survey (ENSANUT for its Spanish acronym). We hypothesized that if people with hypertension are following dietary guidelines, their adherence to DASH diet would be better than among people without hypertension. We also hypothesized that given the role of diet in the development of hypertension (Reddy and Katan, 2004), adherence to the DASH diet among adults with undiagnosed hypertension would be worse than for people without hypertension.

2. Methods

2.1. Data source and population

The 2012 ENSANUT is a cross-sectional, multistage, stratified, and cluster-sampled survey representative of urban and rural areas at the national, regional, and state levels in Mexico. The design and methods are described elsewhere (Gutiérrez et al., 2012). Briefly, the 2012 ENSANUT was conducted between October 2011 and May 2012 and obtained information about sociodemographic, nutrition, and health characteristics from 96,031 people (46,303 adults). Dietary information was collected from a representative subsample (10,885) of the Mexican population using 24-hour recalls (10,885 participants, 3,513 adults > 18 years). In addition, hypertension data were collected from a representative subsample of 10,898 Mexican adults. Informed consent was obtained from each participant, the survey research protocol was approved by the Mexican National Institute of Public Health ethics, biosafety and research committees.

We included men and non-pregnant and non-lactating women >18 years with dietary and hypertension information (2,617) and excluded 57 individuals with extreme total energy intake (expressed as the ratio of total energy intake to estimated energy requirement in logarithmic scale +/- 3 SD), as previously described (López-Olmedo et al., 2016). The analytical sample was composed of 2,560 participants, who were stratified by sex and hypertension status.

2.2. Dietary information

Trained interviewers collected dietary information using electronic 24-hour recalls with an automated 5-step multiple-pass method (United States Department of Agriculture, 2014). The 24-hour recall interviews were administered on a randomly selected day of the week to obtain measurements on both weekdays and weekends. Participants were asked about all foods consumed over the previous 24 h, including beverages, snacks, and items consumed away from home, as well as the amount consumed. Subjects could report their intake as: 1) individual foods, 2) custom recipes (individual ingredients that make up the recipe as reported by participants), and 3) standard recipes (sets of default ingredients that make up a recipe when the informer was not able to provide one). We disaggregated recipes into their component ingredients, considering some could contain different DASH components (e.g., meat stew: animal protein, vegetables, and oil).

Energy and nutrient values from each food group and the total diet were calculated from a food composition table compiled by the National Institute of Public Health (Nutrient Database, Compilation of the National Institute of Public Health, 2012). Portion sizes of each food from the 24-hour recall were estimated based on the Mexican Equivalent Food System (Pérez et al., 2014); they can be consulted in Supplemental Table 1.

2.3. DASH score

To assess the adherence with the DASH dietary pattern, we generated a DASH score based on a prior work by Günther et al. (Günther et al., 2009). Briefly, we identified DASH portion intake goals for eight food groups: total grains, high-fiber grains, vegetables, fruits, total dairy, low-fat dairy, animal protein (red meat, poultry, fish, and eggs), nuts/seeds/legumes, fats/oils, and sweets, based on 2,000 kcal diet. A maximum score of 10 could be achieved for each food group when the intake met the recommendation, while lower intakes were scored proportionately; for instance, if only half of the recommendation is achieved, the score was 5; while a score of 0 was given when there was no intake of any dietary component. The total DASH score was generated by the sum of all component scores (maximum score of 80). Healthy foods receive higher scores at higher intakes, such as fruits and vegetables. On the other hand, foods that should be consumed in moderation (animal protein, sweets, fats, and oils) have a lower score at higher intakes. Details of the index components and the score standards are summarized in Table 1. The DASH scores, total and by dietary component, were converted into a categorical outcome that indicates if the DASH adherence target is achieved. We used the definition suggested by Mellen et al. Individuals who meet at least half of the DASH targets (Total DASH score $\geq$ 40; component of DASH score $\geq$ 5) are considered they adhere to the DASH diet (Mellen et al., 2008).

2.4. Hypertension status

Hypertension status was assessed with the question: “Have you ever been told by a physician that you have high blood pressure or hypertension?”, classifying individuals as “diagnosed hypertension” if they answered “yes”. Participants who answered “no” and had an average systolic blood pressure (SBP) > 140 mmHg or diastolic blood pressure (DBP) > 90 mmHg were classified as “undiagnosed hypertension” (Chobanian et al., 2003). Subjects who responded “no” and had normal blood pressure measurements were classified as “no hypertension”. Blood pressure was measured by trained nurses using mercury sphygmomanometers and the technique and procedures recommended by the American Heart Association (Pickering et al., 2005).

2.5. Health and anthropometric information

Self-reported diabetes status (yes/no) was defined from responses to the question: “Have you ever been told by a physician that you have

Table 1
Targets of dietary components for Dietary Approaches to Stop Hypertension.

Individual Components	DASH Target[a]
Components for which greater intakes receive higher score	
Total fruit	$\geq$ 4 servings/d
Total vegetables	$\geq$ 4 servings/d
Total grains	$\geq$ 6 servings/d
High-fiber grains	$\geq$ 50% of total grain servings/d
Total dairy products	$\geq$ 2 servings/d
Low-fat dairy products	$\geq$ 75% of total dairy servings/d
Nuts, seeds, legumes	$\geq$ 4 servings/d
Components for which lower intakes receive higher scores	
Animal protein (Red meat, poultry, fish, eggs)	$\leq$ 2 servings/d
Sweets	$\leq$ 5 servings/d
Fats, oils	$\leq$ 3 servings/d
DASH, Dietary Approaches to Stop Hypertension	

[a] Targets of individual components shown are based on recommendations for a 2000-kcal diet.

The equivalent of one serving in grams of each food is presented in Supplemental Table 1.

diabetes or high sugar in your blood?". Smoking status was self-reported and categorized as "current", for study participants who reported smoking at least 100 cigarettes during their lifetime and having smoked during the last 30 days; "former", for those who reported smoking at least 100 cigarettes during their lifetime and who did not currently smoke; and "never" for those who never smoked. Current alcohol consumption was self-reported and categorized as yes in participants reported consuming alcohol on at least one occasion in the last 12 months, and as not otherwise. Trained personnel obtained anthropometric measurements using standard procedures (Habitch, 1974). Body weight was measured with participants wearing light clothing using digital scales (model 872, Seca); stadiometers (Dyna-top, model E-1, Mexico) were used to measure height. We calculated the body mass index (BMI) using the standard equation and categorized the results into normal, overweight, and obese based on WHO classification (World Health Organization, 1995).

2.6. Sociodemographic variables

According to the standard definition of the National Institute of Statistics and Geography of Mexico, we defined rural areas as localities with <2,500 inhabitants and urban areas as localities with ≥2,500 inhabitants, and we defined regions as North, Center, and South.[1] An assets index was constructed using principal components analysis, applied to household characteristics and assets. This methodology has been validated and previously described to define the socioeconomic status of the Mexican population (Gutiérrez, 2013). The index was classified into three categories (low, medium, and high) using the tertiles of the distribution of the index as cut-off points. According to the last grade of studies completed, educational level was categorized as elementary or less, middle, high school, and college or more.

2.7. Statistical analysis

All analyses were stratified by sex and hypertension status using means or percentages and the corresponding 95% confidence intervals (95% CI). First, we compared the characteristics of the Mexican adults by using the confidence intervals as hypothesis tests. We additionally performed chi-square tests for categorical variables and Wald tests for continuous variables. Then we used linear regression models to estimate the difference in the prevalence of adherence to the DASH diet, total and dietary components, by sex and hypertension status. Finally, we performed sex-stratified multivariable minimally and fully adjusted Poisson regression models with robust standard errors, considering adherence to the DASH diet, total and by dietary components as the primary outcome, and hypertension status as exposure. For minimally adjusted models, we considered age and total energy intake. For fully adjusted models, we considered age, total energy intake, diabetes status, smoking status, alcohol intake, BMI, geographic region, rural/urban area, educational level, and assets index tertiles. We also performed an adjusted Poisson regression model with an interaction term between hypertension status and sex to test whether the association between hypertension status and the total DASH score differed by sex. We obtained the overall p-value for interaction through global Wald test. We used population-weighted factors for all the statistical analyses and considered the survey's complex sampling design. The significance level was established at alpha 0.05. All analyses were conducted in Stata version 13 (StataCorp, 2013).

[1] States by region. North: Baja California, Baja California Sur, Coahuila, Chihuahua, Durango, Nuevo León, Sonora, and Tamaulipas; Center: Aguascalientes, Ciudad de México, Colima, Estado de México, Guanajuato, Jalisco, Michoacán, Morelos, Nayarit, Querétaro, San Luis Potosí, Sinaloa, and Zacatecas; South: Campeche, Chiapas, Guerrero, Hidalgo, Oaxaca, Puebla, Quintana Roo, Tabasco, Tlaxcala, Veracruz, and Yucatán.

3. Results

Participant characteristics are presented in Table 2. The percentage of men without hypertension was 69.9% versus 30.1% with hypertension, of which 15.5% were undiagnosed, and 14.6% had diagnosed hypertension. Among women, the percentage without hypertension was 68.3% versus 31.7% with hypertension, of which 14.6% were undiagnosed, and 17.1% had diagnosed hypertension.

The total DASH score was less than half of the maximum value (80 points) for all groups (Table 2). Among men, the lowest score was observed among undiagnosed individuals, followed by those without and with diagnosed hypertension (scores of 30.7, 32.8, and 33.5 points, respectively). In women, total scores were similar across hypertension categories (32.8 points among individuals without hypertension; 34.3 and 34.7 points among those with undiagnosed and diagnosed hypertension, respectively). Participants with hypertension were older, less educated, and presented a higher prevalence of overweight, obesity, and diabetes than participants without hypertension. Among men and women with diagnosed hypertension, the time since disease onset was 6.6 and 7.0 years, respectively. Pharmacological treatment was reported by 70.3% of men and 79.2% of women.

Table 3 shows the prevalence of adherence to the DASH diet (total and dietary components) in Mexican men and women by hypertension status. Although not statistically significant, adherence to the DASH diet was higher among men with diagnosed (34.7%) than among those without and with undiagnosed hypertension (26.8 and 21.8%, respectively). Adherence to the recommendations for fruits, animal protein, and sweets was significantly higher in men with diagnosed hypertension than for those with undiagnosed and without hypertension. Similarly, adherence to total dairy and total grains was significantly higher in individuals without hypertension than those with hypertension. Among women, adherence to the DASH diet was significantly higher in those with diagnosed hypertension than women without hypertension (37.6 vs. 26.3%, respectively). Specifically, adherence to animal protein and sweets recommendations was higher in those with diagnosed than those without hypertension. Similarly, adherence to recommendations for animal protein was significantly higher among women with diagnosed hypertension than in those with undiagnosed hypertension.

Table 4 shows adjusted differences in the prevalence of adherence to the DASH diet (total and dietary components) among men by hypertension status. The prevalence of adherence to the total DASH score in those with undiagnosed hypertension was 31% lower than among individuals without the disease (RP 0.69; 95% CI 0.47, 0.99). Specifically, the prevalence of adherence to the recommendations for fruits, total dairy, and animal protein was lower in men with undiagnosed hypertension versus those without hypertension. On the other hand, the prevalence of adherence to the total DASH score was similar in men with diagnosed hypertension relative to men without hypertension (RP 0.97; 95% CI 0.67,1.39). Although not statistically significant, adherence to DASH was 29% lower in men with undiagnosed hypertension than men with diagnosed hypertension (RP 0.71; 95% CI 0.45, 1.10). However, adherence to the recommendations for fruits, animal protein, and sweets was significantly lower in men undiagnosed than those with diagnosed hypertension. All these differences describe the minimally adjusted estimates; however, fully adjusted differences were similar, except for the estimate for men with undiagnosed hypertension relative to men with diagnosed hypertension, where the estimate of animal protein and sweets were no longer statistically significant.

Table 5 shows adjusted differences in the prevalence of adherence to the DASH diet (total and dietary components) among women by hypertension status. The prevalence of adherence to the total DASH score and its components was not significantly different across hypertension categories. These results describe the minimally adjusted estimates; however, fully adjusted differences were similar, except for the adherence to the recommended vegetable intake was 25% higher in women with undiagnosed hypertension than those without the disease (95% CI

Table 2
Characteristics of Mexican men and women by hypertension status (n = 2,560).

	Men							Women						
Hypertension Status	No hypertension		Undiagnosed hypertension		Diagnosed hypertension		p-value	No hypertension		Undiagnosed hypertension		Diagnosed hypertension		p-value
N	670		210		181			955		212		332		
Population represented	16,178,956		3,595,064		3,378,423			21,521,408		4,209,900		4,934,438		
	Mean	**95% CI**	**Mean**	**95% CI**	**Mean**	**95% CI**		**Mean**	**95% CI**	**Mean**	**95% CI**	**Mean**	**95% CI**	
Total DASH score	32.8	31.7, 34.0	30.7	28.6, 32.8	35.4	32.7, 38.0	**0.023**	32.8	31.9, 33.7	34.3	32.3, 36.3	34.7	32.6, 36.9	0.156
Time since diagnosis (years)	–	–	–	–	6.6	4.5, 8.6		–	–	–	–	7.0	5.5, 8.6	
	Mean	**95% CI**	**Mean**	**95% CI**	**Mean**	**95% CI**		**Mean**	**95% CI**	**Mean**	**95% CI**	**Mean**	**95% CI**	
Age (years)	40.9	39.0, 42.8	50.7	47.6, 53.8	57.3	54.6, 60.0	**<0.001**	40.2	38.9, 41.4	49.6	46.7, 52.5	56.6	54.3, 58.8	**<0.001**
BMI (kg/m^2)	26.3	25.8, 26.7	28.3	27.5, 29.1	28.6	27.6, 29.6	**<0.001**	28.2	27.7, 28.6	30.5	29.4, 31.6	31.3	30.4, 32.3	**<0.001**
	%	**95% CI**	**%**	**95% CI**	**%**	**95% CI**		**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**	
Pharmacological treatment	–	–	–	–	70.3	60.4, 78.6		–	–	–	–	79.2	70.0, 86.1	
Diabetes	3.8	2.2, 6.3	6.3	3.1, 12.1	33.3	23.3, 45.2	**<0.001**	4.5	3.1, 6.6	18.7	10.5, 31.2	29.1	22.3, 37.0	**<0.001**
Alcohol consumption	80.3	75.5, 84.4	77.3	68.8, 84.0	68.0	56.1, 77.9	**<0.001**	77.2	73.0, 80.9	75.8	64.7, 84.2	78.1	70.3, 84.2	0.051
Smoking status														
Never	44.8	39.2, 50.6	40.0	31.0, 49.8	41.5	31.6, 52.3		79.5	75.1, 83.3	79.7	68.2, 87.7	79.5	71.7, 85.5	
Former	25.7	20.9, 31.1	34.8	25.4, 45.5	40.0	29.7, 51.1	0.073	8.9	6.6, 12.1	3.1	1.5, 6.4	10.3	6.7, 15.6	0.176
Current	29.5	24.5, 35.0	25.2	18.4, 33.5	18.5	10.6, 30.4		11.6	8.5, 15.4	17.2	9.4, 29.3	10.2	5.5, 18.0	
BMI categories														
Normal	44.1	38.5, 49.8	21.9	15.5, 30.0	18.1	10.3, 29.7	**<0.001**	27.9	23.9, 32.3	15.3	9.9, 22.8	16.4	11.6, 22.7	**<0.001**
Overweight	37.5	32.0, 43.3	44.0	34.2, 54.2	52.9	41.9, 63.6		41.1	36.4, 46.1	30.4	21.8, 40.7	32.9	24.7, 42.3	
Obesity	18.4	14.7, 22.9	34.2	25.3, 44.2	29.0	20.3, 39.6		31.0	26.8, 35.5	54.3	43.9, 64.3	50.7	42.1, 59.3	
Area														
Urban	72.3	67.9, 76.3	71.8	63.4, 78.9	72.9	64.3, 80.1	0.982	74.7	71.3, 77.9	80.2	73.0, 85.8	77.5	71.3, 82.7	0.313
Rural	27.7	23.7, 32.0	28.2	21.1, 36.6	27.1	19.9, 35.7		25.3	22.1, 28.7	19.8	14.2, 27.0	22.5	17.3, 28.7	
Region														
North	20.8	17.3, 24.7	24.9	18.2, 33.2	29.9	21.9, 39.2	0.119	18.4	15.6, 21.5	21.5	14.6, 30.6	28.8	22.3, 36.3	0.118
Central	47.5	41.9, 53.2	41.5	31.8, 51.9	49.2	38.5, 60.1		50.3	45.7, 55.0	51.0	40.4, 61.5	46.4	37.9, 55.1	
South	31.7	27.3, 36.5	33.5	25.3, 42.9	20.9	14.5, 29.2		31.3	27.4, 35.4	27.5	19.9, 36.6	24.8	18.8, 31.9	
Assets index														
Low	33.6	29.1, 38.4	35.4	27.1, 44.8	23.6	16.8, 32.0	0.110	29.0	25.2, 33.1	25.1	17.2, 35.1	23.5	18.0, 30.1	0.444
Medium	30.7	25.8, 36.1	29.8	21.9, 39.1	25.9	17.9, 35.9		27.7	23.7, 32.0	32.0	23.0, 42.6	36.0	27.9, 45.1	
High	35.7	30.1, 41.8	34.8	25.4, 45.5	50.5	39.6, 61.3		43.4	38.3, 48.6	42.9	32.1, 54.4	40.5	31.9, 49.6	
Education level														
Elementary school or less	40.8	35.5, 46.3	57.5	47.1, 67.2	59.1	47.7, 69.6	0.007	38.3	33.9, 42.8	62.2	51.6, 71.7	75.1	67.9, 81.1	<0.001
Middle school	29.4	24.1, 35.2	13.0	7.5, 21.4	17.9	11.0, 27.8		29.8	25.6, 34.3	19.4	12.8, 28.1	10.2	6.5, 15.6	
High school	18.7	14.3, 24.1	22.1	13.6, 33.6	11.5	5.1, 24.2		19.7	16.1, 23.9	8.7	4.7, 15.8	9.1	5.6, 14.5	
College or more	11.1	7.7, 15.7	7.4	3.8, 14.0	11.5	6.4, 19.7		12.3	9.3, 16.1	9.7	4.7, 18.9	5.6	3.1, 9.9	

*Values are presented as means or percentages and 95% Confidence Intervals (95% CI). Estimates were weighted to adjust for unequal probability of sampling and to be nationally representative. Significant differences by hypertension status and sociodemographic category between each sex. $\chi 2$ test and Wald test, **P < 0·05**.

1.02, 1.52). Also, the adherence to animal protein intake was 23% (95% CI 1.01, 1.50) higher in women with diagnosed hypertension relative to women without hypertension. Adherence to animal protein recommendations was 26% lower among women with undiagnosed versus those with diagnosed hypertension (RP 0.74; 95% CI 0.55, 0.98).

4. Discussion

Overall, regardless of hypertension status, adherence to the total DASH score was low, with 35% of men and 38% of women with diagnosed hypertension adhering to recommended guidelines. We found a lower prevalence of adherence to the total DASH score in men with undiagnosed versus those without hypertension. Men with undiagnosed hypertension had lower adherence to the recommended intakes for fruit, total dairy, and animal protein than those without hypertension. Although not statistically significant, adherence to the DASH score was also lower among men with undiagnosed versus diagnosed hypertension. Among women, we did not find significant differences in the adherence to the DASH score; however, we did observe differences in vegetable consumption and animal protein intake.

The lower adherence to the DASH diet found among men with undiagnosed versus diagnosed hypertension is in line with what León-Muñoz, et al., 2012 found in adults from Spain (León-Muñoz et al., 2012). These results are also expected since hypertension diagnosis provides the opportunity to change dietary and lifestyle habits. On the other hand, individuals with undiagnosed hypertension might not feel the need to change their dietary and lifestyle habits since they might not have symptoms or do not relate them to high blood pressure (Chang et al., 2008). That we found that only 22% of the adults with undiagnosed hypertension had minimal adherence to nutritional recommendations can have important health implications considering that 40% of Mexican adults with hypertension do not know about their condition (Campos-Nonato et al., 2018). It is necessary to reinforce the screening programs to improve the identification of individuals with high blood pressure and promote healthy lifestyles and diets in the general population.

The lower consumption of fruits, high-fiber grains, and dairy in men with undiagnosed hypertension versus individuals without hypertension can explain the difference in adherence to the total DASH score between these two groups. Like our results, a previous study found a lower consumption of fruits, dairy and whole grains among Brazilian adults with high blood pressure than those with normal blood pressure levels (De Paula et al., 2012). These results are expected given the important role of fruits, dairy, and high-fiber grains on the contribution of potassium, calcium, and fiber, respectively, and in controlling blood pressure (Van Mierlo et al., 2010; McCarron et al., 1982; Aleixandre and Miguel, 2016; McCarron et al., 1984; McGrane et al., 2011).

Although the model with an interaction between hypertension status and sex was not statistically significant (P-interaction = 0.606), we found different results on the adherence to the DASH diet by

Table 3
Prevalence of adherence to the DASH diet (total and dietary components) in Mexican men and women by hypertension status (n = 2560).

Hypertension Status	Men								
	No hypertension		Undiagnosed hypertension		Diagnosed hypertension		No Hypertension vs Undiagnosed	No Hypertension vs Diagnosed	Undiagnosed vs Diagnosed
	%	95% CI	%	95% CI	%	95% CI	P-value	P-value	P-value
Adherence to total DASH diet	26.8	21.7, 31.9	21.8	14.2, 29.5	34.7	23.9, 45.5	0.290	0.198	0.053
Adherence to DASH components									
Fruits	26.9	21.7, 32.0	13.7	6.6, 20.7	27.9	18.5, 37.4	0.003*	0.845	0.018*
Vegetables	39.8	34.5, 45.1	47.7	37.8, 57.6	50.4	39.4, 61.4	0.166	0.096	0.714
Grains									
Total	98.7	97.8, 99.6	97.5	93.1, 99.1	91.3	84.0, 98.6	0.388	0.049*	0.117
High fiber	3.2	1.5, 4.9	1.7	0.0, 3.5	3.6	1.2, 10.1	0.255	0.860	0.397
Dairy									
Total	39.9	34.0, 45.8	24.5	15.4, 33.6	37.7	26.7, 48.6	0.004*	0.713	0.072
Low-fat	35.4	29.6, 41.3	29.4	19.6, 39.2	42.1	31.0, 53.2	0.317	0.283	0.092
Nuts, seeds, legumes	36.4	31.3, 41.4	42.9	33.0, 52.8	35.8	26.0, 45.6	0.248	0.924	0.324
Animal protein	54.0	48.3, 59.6	39.4	30.0, 48.8	56.8	46.2, 67.5	0.008*	0.631	0.014*
Sweets	14.1	10.2, 18.0	12.2	7.5, 17.0	25.1	16.1, 34.1	0.567	0.028*	0.011*
Fats, oils	67.5	61.9, 73.1	69.3	59.4, 79.1	67.9	57.6, 78.3	0.758	0.942	0.856

Hypertension Status	Women								
	No hypertension		Undiagnosed hypertension		Diagnosed hypertension		No Hypertension vs Undiagnosed	No Hypertension vs Diagnosed	Undiagnosed vs Diagnosed
	%	95% CI	%	95% CI	%	95% CI	P-value	P-value	P-value
Adherence to total DASH diet	26.3	22.3, 30.2	27.2	18.9, 35.5	37.6	29.4, 45.7	0.844	0.013*	0.080
Adherence to DASH components									
Fruits	29.9	25.7, 34.2	33.5	23.5, 43.4	32.0	24.2, 39.9	0.524	0.650	0.822
Vegetables	46.8	42.1, 51.5	57.0	46.4, 67.6	50.0	41.1, 58.8	0.085	0.536	0.328
Grains									
Total	97.4	95.8, 99.1	99.2	97.3, 99.7	97.0	94.5, 99.6	0.082	0.781	0.124
High fiber	5.2	3.0, 7.4	2.8	0.5, 5.1	4.3	0.8, 7.8	0.154	0.674	0.486
Dairy									
Total	45.2	40.7, 49.7	46.5	35.6, 57.4	45.6	37.0, 54.1	0.829	0.942	0.895
Low-fat	42.3	37.8, 46.9	35.0	24.8, 45.1	45.7	37.1, 54.2	0.190	0.502	0.117
Nuts, seeds, legumes	33.0	28.6, 37.4	33.1	24.5, 41.7	35.7	27.4, 44.1	0.984	0.572	0.665
Animal protein	44.3	39.7, 49.0	40.3	30.2, 50.4	55.6	47.0, 64.1	0.469	0.025*	0.023*
Sweets	13.6	10.5, 16.7	20.2	12.2, 28.2	20.8	14.3, 27.2	0.132	0.044*	0.909
Fats, oils	65.3	60.7, 69.9	72.4	63.9, 80.9	63.6	54.8, 72.4	0.153	0.735	0.150

Values are presented as Prevalence (%) and 95% Confidence Intervals (95% CI). Estimates were weighted to adjust for unequal probability of sampling and to be nationally representative. DASH, Dietary Approaches to Stop Hypertension based on Gunther et al methodology.
Adherence to DASH was defined as meeting at least half of the total score based on Mellen et al. methodology.
*p-value < 0.05.

hypertension status among men and women. Among men, the adherence was lower in individuals undiagnosed than without hypertension. On the other hand, the adherence was not different in men with diagnosed versus those without hypertension. An explanation of the above is that we might have observed men with diagnosed hypertension with highly variable adherence to healthier diets that overall could be similar to those without hypertension. Specifically, the adherence to healthy diets can be better in men with recent hypertension diagnosis as a strategy to improve their health condition. However, the long-term maintenance of dietary habits can be challenging (Sofer et al., 2015), especially for men, and therefore their adherence to healthy diets may deteriorate over time. This potential explanation is in line with what has been observed in Polish adults with diagnosed hypertension, which reported lower adherence to non-pharmacological treatment over time (Jankowska-Polańska et al., 2016). It was not possible to identify changes in the adherence to the DASH diet by the duration of the disease given the restricted sample size of individuals with diagnosed hypertension. Future studies are needed to study the dynamics of adherence to healthy dietary patterns based on the time since a chronic disease diagnosis.

Among women, the adherence appeared to be higher in individuals with diagnosed than those without hypertension. These last results align with findings in the Asian adult population. They found that women with hypertension had better adherence to treatment for the disease than those individuals without hypertension (Kim and Kong, 2015; Liew et al., 2019). The latter can be explained by sociocultural factors. Studies show that women are more likely to adopt healthier lifestyles, including adopting the DASH-type diet compared to their counterparts without the disease when they have a chronic disease diagnosis (Alefan et al., 2019; Zanetti et al., 2015). In Mexico, women use health services more often, particularly if living with a chronic disease (Molina-Rodríguez et al., 2006; Mercado-Martínez et al., 2003). Beyond the potential differences by hypertension status among men and women, the low adherence to the DASH diet in Mexican adults shows the need to improve the dietary information received by individuals to prevent and treat hypertension.

The adherence to the DASH diet was not different between women with undiagnosed and those without hypertension. However, we observed that women with undiagnosed hypertension had higher adherence to vegetable recommendations than those without

Table 4
Prevalence ratios for adherence to the DASH diet (total and dietary components) in Mexican adult men by hypertension status (n = 1061).

Hypertension Status		Men											
		Undiagnosed vs No Hypertension				Diagnosed vs No Hypertension				Undiagnosed vs Diagnosed			
		Minimally adjusted Model[1]		Adjusted Model[2]		Minimally adjusted model[1]		Adjusted Model[2]		Minimally adjusted model[1]		Adjusted Model[2]	
	DASH Target Adherence score	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI
DASH Adherence	**40**	**0.69**	**0.47, 0.99**	**0.71**	**0.50, 0.99**	0.97	0.67, 1.39	0.90	0.64, 1.25	0.71	0.45, 1.10	0.79	0.52, 1.21
Food group adherence													
Fruits	5	**0.47**	**0.27, 0.80**	**0.48**	**0.29, 0.80**	0.90	0.60, 1.36	0.74	0.50, 1.10	**0.52**	**0.28, 0.96**	0.65	0.35, 1.17
Vegetables	5	1.15	0.89, 1.48	1.17	0.92, 1.50	1.15	0.88, 1.52	1.23	0.93, 1.62	0.99	0.75, 1.33	0.95	0.70, 1.30
Grains													
Total	2.5	0.99	0.96, 1.01	0.99	0.96, 1.01	0.92	0.85, 1.01	0.94	0.89, 1.00	1.07	0.98, 1.16	1.04	0.98, 1.11
High fiber	2.5	0.44	0.14, 1.36	0.37	0.11, 1.21	0.78	0.23, 2.72	0.51	0.11, 2.39	0.56	0.13, 2.45	0.73	0.15, 3.57
Dairy													
Total	2.5	**0.61**	**0.41, 0.90**	**0.62**	**0.42, 0.89**	0.94	0.67, 1.31	**0.70**	**0.53, 0.94**	0.65	0.41, 1.03	0.87	0.57, 1.33
Low-fat	2.5	0.8	0.55, 1.18	0.81	0.57, 1.15	1.15	0.84, 1.58	0.95	0.70, 1.29	0.70	0.46, 1.06	0.86	0.58, 1.28
Nuts, seeds, legumes	5	1.11	0.85, 1.45	1.12	0.87, 1.44	0.89	0.65, 1.21	1.01	0.74, 1.37	1.25	0.88, 1.78	1.11	0.78, 1.57
Animal protein	5	**0.69**	**0.53, 0.89**	**0.69**	**0.53, 0.89**	0.95	0.77, 1.18	0.93	0.74, 1.17	**0.72**	**0.54, 0.97**	0.74	0.54, 1.01
Sweets	5	0.81	0.50, 1.31	0.83	0.52, 1.31	1.53	0.98, 2.38	1.40	0.86, 2.28	**0.53**	**0.32, 0.87**	0.59	0.33, 1.03
Fats, oils	5	0.98	0.83, 1.14	0.98	0.83, 1.14	0.91	0.77, 1.08	0.93	0.78, 1.11	1.07	0.87, 1.31	1.05	0.84, 1.29

Values are presented as Prevalence Ratios (PR) and 95% Confidence Intervals (95% CI). Estimates were weighted to adjust for unequal probability of sampling and to be nationally representative.
DASH, Dietary Approaches to Stop Hypertension based on Gunther et al methodology.
Adherence to DASH was defined as meeting at least half of the total score based on Mellen et al. methodology.
1. Adjusted for age and total energy intake. 2. Adjusted for age, total energy intake, diabetes status, smoking status, alcohol intake, BMI, geographic region, rural/urban area, educational level, and assets index tertiles.
p-value < 0.05.

hypertension. Even though the vegetable intake might be beneficial for blood pressure, it might not be sufficient if other food components are not consumed as recommended. Women with undiagnosed hypertension might have this health condition given the low adherence to the overall DASH recommendations. In addition, we found that the adherence to animal protein recommendations was higher among women with diagnosed hypertension versus those without and undiagnosed hypertension. The latter is an expected result considering they are aware of their disease, and probably they had been received dietary intervention as part of their non-pharmacological treatment. The Mexican Official Standard for the prevention, treatment, and control of hypertension (NOM-030-SSA2-1999) recommends moderate intakes of animal-based foods, simple sugars, and low intakes of salt (Ministry of Health [Mexico], 2011). It is, therefore, likely that health practitioners focused their advice on the reduction of these components.

Table 5
Prevalence ratios for adherence to the DASH diet (total and dietary components) in Mexican adult women by hypertension status (n = 1,499).

Hypertension Status		Women											
		Undiagnosed vs No Hypertension				Diagnosed vs No Hypertension				Undiagnosed vs Diagnosed			
		Minimally adjusted Model[1]		Adjusted Model[2]		Minimally adjusted model[1]		Adjusted Model[2]		Minimally adjusted model[1]		Adjusted Model[2]	
	DASH Target Adherence score	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI
DASH Adherence	**40**	0.93	0.65, 1.32	0.96	0.68, 1.35	1.21	0.91, 1.61	1.24	0.93, 1.67	0.76	0.53, 1.11	0.77	0.53, 1.12
Food group adherence													
Fruits	5	1.04	0.74, 1.46	1.07	0.77, 1.49	0.95	0.70, 1.29	0.99	0.72, 1.35	1.09	0.74, 1.60	1.09	0.74, 1.61
Vegetables	5	1.23	0.99, 1.53	**1.25**	**1.02, 1.52**	1.11	0.88, 1.39	1.14	0.92, 1.41	1.11	0.85, 1.45	1.10	0.86, 1.40
Grains													
Total	2.5	1.02	1.00, 1.04	1.01	0.99, 1.03	0.99	0.96, 1.02	0.99	0.96, 1.02	1.03	0.99, 1.06	1.02	0.99, 1.05
High fiber	2.5	0.53	0.22, 1.31	0.54	0.22, 1.33	0.75	0.29, 1.96	0.80	0.31, 2.06	0.72	0.23, 2.26	0.68	0.21, 2.24
Dairy													
Total	2.5	0.98	0.76, 1.26	0.96	0.75, 1.21	0.93	0.74, 1.18	0.90	0.71, 1.12	1.05	0.78, 1.41	1.07	0.81, 1.41
Low-fat	2.5	0.80	0.59, 1.09	0.79	0.59, 1.05	1.00	0.79, 1.27	0.98	0.77, 1.24	0.80	0.56, 1.14	0.81	0.57, 1.14
Nuts, seeds, legumes	5	1.03	0.77, 1.38	1.03	0.77, 1.38	1.13	0.85, 1.49	1.11	0.84, 1.47	0.92	0.65, 1.30	0.93	0.65, 1.33
Animal protein	5	0.87	0.66, 1.15	0.91	0.69, 1.19	1.15	0.94, 1.42	**1.23**	**1.01, 1.50**	0.76	0.56, 1.02	**0.74**	**0.55, 0.98**
Sweets	5	1.28	0.78, 2.08	1.15	0.69, 1.93	1.30	0.86, 1.96	1.11	0.72, 1.69	0.98	0.61, 1.59	1.04	0.63, 1.74
Fats, oils	5	1.06	0.93, 1.22	1.04	0.91, 1.20	0.91	0.77, 1.07	0.88	0.75, 1.04	1.17	0.98, 1.40	1.18	0.98, 1.42

Values are presented as Prevalence Ratios (PR) and 95% Confidence Intervals (95% CI). Estimates were weighted to adjust for unequal probability of sampling and to be nationally representative.
DASH, Dietary Approaches to Stop Hypertension based on Gunther et al methodology.
Adherence to DASH was defined as meeting at least half of the total score based on Mellen et al. methodology.
1. Adjusted for age and total energy intake.
2. Adjusted for age, total energy intake, diabetes status, smoking status, alcohol intake, BMI, geographic region, rural/urban area, educational level, and assets index tertiles.
p-value < 0.05.

5. Limitations

This study has several limitations. First, we based the analyses on a single 24-hour recall, which does not differentiate between- and within-person variability, and therefore usual intake cannot be estimated. However, most of the dietary components analyzed in this study are frequently consumed among the Mexican population (Rivera et al., 2016). Second, we cannot disregard the potential loss of accuracy to detect differences in the total DASH score by hypertension status due to the truncated nature of the index score. That is, there is likely variability in food intakes among those with the lowest and highest scores that are no longer considered when the score is assigned. However, the use of 24-hour recalls provides greater precision than any concomitant loss of precision that may be attributable to a truncated effect in distributing the scores. Third, we acknowledge that the cut-off points for determining adherence to the DASH diet and its components may be arbitrary. However, the methodology developed by Mellen et al. is simple and has the advantage of reflecting the minimum concordance with the DASH diet recommendations and has been used in different studies that have evaluated adherence to the score (Mellen et al., 2008).

6. Conclusions

In conclusion, we observed that adults, regardless of their hypertension status, had low adherence to several DASH components and, therefore, to a healthy diet. These results suggest that national and international recommendations have not greatly influenced the diet of Mexican adults. The findings emphasize the need for public health policies that promote the adherence to healthy dietary patterns that prevent the onset of hypertension and its complications, considering the potential differences by sex.

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CRediT authorship contribution statement

Alan Reyes-García: Formal analysis, Data curation, Writing – original draft, Visualization. **Nancy López-Olmedo:** Conceptualization, Writing – review & editing, Visualization. **Ana Basto-Abreu:** Writing – review & editing, Visualization. **Teresa Shamah-Levy:** Writing – review & editing, Visualization. **Tonatiuh Barrientos-Gutierrez:** Conceptualization, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition.

Declaration of Competing Interest

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Appendix A. Supplementary data

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