

# Traditional Mexican Diet

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Grains, legumes, and vegetables were the most representative food groups in the traditional Mexican diet (TMexD), as these were mentioned in most (75%) of the studies, including all the subgroups evaluated. Additionally, maize (mostly as tortillas), beans, squash, tomato, chile, and onion are potentially fundamental elements of the TMexD, as these were the only individual foods cited in most studies, including all the subgroups evaluated. Indeed, maize (a grain), beans (a legume), and squash (a vegetable) have long represented the basic foods in Mexico, as they form part of the ancient agro-ecosystem known as *Milpa*. Other groups that were also mentioned in all the studies and subgroup analyses were maize products, fruits, beverages, fish and seafood, meats, sweets and sweeteners, and herbs and condiments. However, these were mentioned in different frequencies in the different subgroups assessed (i.e., in  $\geq 75\%$  of studies in some subgroups while in only 50% of studies in others).

Keywords: Mexican diet ; traditional diet ; traditional eating ; definition ; non-communicable diseases ; risk factors ; systematic review

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## 1. Introduction

Diverse international health organisations have proposed promoting traditional diets to tackle the growing global non-communicable disease (NCD) and obesity rates <sup>[1][2]</sup>. These diets are generally considered healthy diets <sup>[1][3]</sup>, as they contain large amounts of plant-based foods such as grains, vegetables, legumes, tubers and fruits, and low amounts of foods of animal origin, such as red meat <sup>[3][4][5][6]</sup>. For instance, the traditional Mediterranean diet has been consistently associated with a reduced risk of developing cardiovascular diseases, cancer, and diabetes <sup>[7][8][9][10][11]</sup>. As such, adopting a Mediterranean diet is strongly encouraged in the literature <sup>[12]</sup>. However, promoting the Mediterranean diet might not be feasible in all countries, as different regions might have their own culturally and climate-appropriate food products <sup>[13]</sup>.

In Mexico, promoting the traditional Mexican diet (TMexD) could potentially constitute a public health measure to address the country's high NCD rates <sup>[14]</sup>. Mortality from NCDs in Mexico has increased by 27% between 1990 and 2017 <sup>[14]</sup>, which has been largely attributed to the nutrition transition the country has experienced <sup>[15][16]</sup>. However, the literature currently presents diverse definitions of the TMexD, which is potentially due to the changing food culture in Mexico throughout its history <sup>[17][18]</sup>. These diverse definitions limit the possibility of evaluating the TMexD's association with health, as different definitions can lead to different outcomes <sup>[19]</sup>. Determining what constitutes a 'traditional diet' is also challenging, as this term can refer to diets consumed in a specific region within a country <sup>[20]</sup>, diets consumed by indigenous populations <sup>[21][21]</sup>, diets present before the industrialisation period <sup>[22]</sup>, or diets conformed by locally produced and culturally appropriate foods <sup>[23]</sup>. These factors render the definition of the TMexD challenging, and to our knowledge, no consistent definition of the TMexD exists. However, establishing a consistent definition of this traditional dietary pattern and evaluating its association with health outcomes would be invaluable before considering its promotion to reduce NCD rates in Mexico <sup>[24]</sup>.

## 2. Definition of the Traditional Mexican Diet

The present study defined the TMexD by listing the food groups and food items most often referred to as traditional Mexican in the literature. The analysis was conducted for all included studies but also separately, according to the type of study and region of Mexico. Since most (71%) of the literature reviews referred to diets before or around the Spanish colonisation (i.e., the 16th century) and all original studies reported more current intakes (i.e., 1943 onwards), this separate analysis allowed the examination of variations in the TMexD definition through time. In addition, the subgroup analysis according to different geographical areas of Mexico (i.e., North, Central, South, and all regions) allowed the examination of potential marked differences across regions.

## 2.1. Food Groups Present Consistently in the Traditional Mexican Diet

The results suggest that grains, legumes, and vegetables were the most representative food groups in the TMexD, as these were mentioned in most (75%) of the studies, including all the subgroups evaluated. Additionally, maize (mostly as tortillas), beans, squash, tomato, *chile*, and onion are potentially fundamental elements of the TMexD, as these were the only individual foods cited in most studies, including all the subgroups evaluated. Indeed, maize (a grain), beans (a legume), and squash (a vegetable) have long represented the basic foods in Mexico, as they form part of the ancient agro-ecosystem known as *Milpa* [25]. *Chile*, while also present only in some *milpa* cultivations [25][26], is specifically characteristic of the Mexican diet and its cuisine [27], which might also explain its high citation. Often, *chile* is also combined with tomato and onion in sauces to condiment meals [28].

Other groups that were also mentioned in all the studies and subgroup analyses were maize products, fruits, beverages, fish and seafood, meats, sweets and sweeteners, and herbs and condiments. However, these were mentioned in different frequencies in the different subgroups assessed (i.e., in  $\geq 75\%$  of studies in some subgroups while in only 50% of studies in others). Specifically, maize products, beverages, meats, and herbs and condiments were mentioned in 75% of the literature reviews, but only in 50% of the original studies. Likewise, studies referring to Northern and Southern Mexico mentioned meats, herbs and condiments, and maize products less frequently than other regions, respectively. On the other hand, studies referring to Central Mexico mentioned fruit less frequently but fish and seafood and beverages more frequently. Lastly, records referring to all the regions mentioned sweets and sweeteners more frequently than the rest of the specific geographical locations.

Some possible explanations for these differences might exist. For instance, literature reviews could have described a more detailed diet, thus emphasising the ways in which maize was consumed, and the herbs and condiments used for cooking. A second explanation is that *a posteriori* analyses, which were used in 44% of the original studies, might have emphasised only the foods that have the largest contribution to the TEI [29]. Thus, they might have not reported foods that are characteristic of the TMexD but are generally non-energy dense, such as herbs and condiments [30]. While some Mexican condiments do provide large amounts of calories, mainly from fat (i.e., *adobo*, *mole*, *pipián*), all of the herbs and condiments identified in this review were non-energy dense [30][31][32], and thus these potentially do not contribute largely to the TEI. However, these reasons do not explain why meats and beverages were reported less frequently in original studies. As for the regional differences in the TMexD, the results indicate that beverages, fish and seafood, meats, fruits, and maize products are consumed differently throughout the country. However, these regional differences might have only been representative of past times, as current intakes of these food groups disagree with the results observed. For example, although meats were less reported in the north, the meat intake has long been higher in this region of Mexico [33]. Likewise, although fruits were less reported in Central Mexico, the fruit intake has been higher in this region both in the past [34] and present times [35][36]. Thus, given that the different study designs or the regional variations might not explain these differences in frequency of citation, these food groups might simply not have a primary presence in the TMexD. While these food groups are highly likely to form part of the TMexD, they might be less representative of the diet than grains, tubers, legumes, and vegetables.

## 2.2. Foods Not Consistently Mentioned in the Traditional Mexican Diet

Some food groups (oils and fats, nuts and seeds, eggs, dairy, insects, and reptiles) were mentioned only in some, but not all, the subgroups of the studies. Specifically, nuts and seeds, insects, and reptiles were present in literature reviews but were not reported by original studies, which might imply that they have become less representative of the TMexD over time. Indeed, the current consumption of nuts and seeds in Mexico is low [36][37], and insects and reptiles no longer form part of the usual diet, as these are only consumed as exotic foods [38] or in some southern or rural areas in Mexico [27][39][40][41]. In contrast, dairy and eggs were only mentioned in original studies, but not in literature reviews, which might imply that these foods were only recent inclusions to the Mexican diet. As for the regional subgroup differences, only studies referring to the north mentioned eggs and dairy, while only studies referring to Central and Southern Mexico included oils and fats, nuts and seeds, insects, and reptiles. It is possible that these food groups were consumed to different extents in the different country regions in the past. However, some of these differences might not have persisted, as current intakes of oils and fats, and nuts and seeds, are similar in all regions of the country, and current intakes of dairy are higher in the centre, rather than in the north of Mexico [35][36].

Including these food groups that were not consistently mentioned in a definition of the TMexD might require careful consideration. Oils and fats, and nuts and seeds might still form part of the TMexD, although these might be less representative of the diet than the other groups previously mentioned. Oils and fats, and nuts and seeds are not only consumed in present times, but they were also mentioned both in all studies combined and in studies describing all

geographical regions in Mexico. On the other hand, eggs and dairy might not be as representative of the TMexD as other foods that have long formed part of the Mexican food tradition. Insect consumption, while still well accepted at the population level, might only occur occasionally [38]. However, reptile consumption may no longer be as relevant in Mexico, especially if this diet was to be promoted in the general population. Reptiles were absent in all studies combined and those describing all geographical regions, and their commercialisation (i.e., turtles, iguanas, and snakes) is prohibited in order to preserve the species [39][42][43].

### 2.3. Specific Food Items Mentioned in the Traditional Mexican Diet

There were many individual foods mentioned in the included studies (**Table 1**). While all the food items mentioned in the results might be considered when defining the TMexD, special consideration might be needed for the items that, based on their absence in food classification systems, are no longer common in Mexico. This might be true for some meats (i.e., dogs, boar, *tlacuache*, squirrel, partridges, and gopher), vegetables (i.e., *Spirulina* algae, *maguey*, *mesquite*, *quintoniles*, and *Setaria*), fruits (i.e., *ramón*), and herbs (i.e., *acedera*). Conversely, since processed or industrialised products might represent less traditional items, foods such as vegetable oils, soda, *pan dulce* (sweet bread), desserts, and sweets might only be present in limited amounts. Future studies should examine the feasibility of integrating these unusual or processed foods in a traditional diet, especially if the purpose is to promote it as a public health strategy to reduce NCD rates.

**Table 1.** Specific food items mentioned in the TMexD definitions\*

Food group	Specific food items mentioned
<b>Grains and tubers</b>	Maize, amaranth, rice, wheat <sup>1</sup> , potato, sweet potato, yucca.
<b>Maize products</b>	<b>Tortilla, <i>tamales</i><sup>2</sup>, <i>atole</i><sup>3</sup>, soups (<i>pozole</i><sup>4</sup>, <i>menudo</i><sup>5</sup>), mixed dishes<sup>7</sup>, <i>pinole</i><sup>8</sup>.</b>
<b>Legumes</b>	Beans.
<b>Vegetables</b>	Squash, <i>chayote</i> , <i>nopales</i> , tomato, tomatillo, carrot, lettuce, purslane, <i>quelites</i> , <i>papaloquelite</i> , <i>quintoniles</i> , mushroom, squash blossoms, <i>maguey</i> , <i>Spirulina</i> algae, <i>guaje</i> , <i>huauzontle</i> , <i>mesquite</i> , <i>Setaria</i> .
<b>Fruits</b>	Anona, apple, banana, berries, capulín, citrus fruits <sup>9</sup> , guava, <i>guanábana</i> , <i>jícama</i> , <i>mamey</i> , mango, melon, <i>nanche</i> , papaya, peach, pear, pineapple, pitahaya, plum, prickly pear, <i>ramón</i> , <i>tejocote</i> , <i>zapote</i> .
<b>Meats</b>	Turkey, chicken, venison, pork, rabbit, hare, beef, lamb, chevon, dog, duck, armadillo, <i>tlacuache</i> , boar, gopher, partridges, squirrel.
<b>Herbs and condiments</b>	Annato, <i>acedera</i> or <i>lengua de vaca</i> , <i>acuyo</i> or <i>hoja santa</i> , chile, <i>chipilín</i> , coriander, <i>epazote</i> , garlic, onion, parsley, pepper, vanilla, salt.
<b>Oils and fats</b>	Avocado <sup>10</sup> , vegetable oil, cream, lard, animal fats.
<b>Nuts and seeds</b>	Peanuts, pumpkin seeds, chia seeds, sesame seeds.
<b>Beverages†</b>	Chocolate drinks, <i>pulque</i> <sup>11</sup> , <i>tesgüino</i> <sup>12</sup> , coffee, soda, <i>aguas frescas</i> <sup>13</sup> , natural fruit juice, <i>pozol</i> <sup>14</sup> .
<b>Fish and seafood</b>	Catfish, shrimp.

<b>Sweets and sweeteners</b>	Honey <sup>15</sup> , <i>pan dulce</i> <sup>16</sup> , sugar and sugarcane, desserts, sweets.
<b>Dairy</b>	Cheese, milk.
<b>Eggs</b>	Chicken eggs.
<b>Insects</b>	Grasshoppers and locusts, <i>maguey</i> worms <sup>17</sup> , ants and their larvae <sup>18</sup> , <i>amoyotl</i> <sup>19</sup> , <i>ahuahutle</i> <sup>20</sup> .
<b>Reptiles</b>	Snakes, turtles, iguana, lizard.

\*Includes items mentioned in  $\geq 25\%$  of all studies, including those mentioned in  $\geq 25\%$  subgroup of studies (e.g., those referring to Northern Mexico only). †Excluding maize-based drinks. 1: includes bread, pasta, and wheat tortillas. 2: traditional dish prepared with maize dough. 3: hot beverage prepared with maize dough. 4: soup made with maize kernels, meat, chile, and seasonings. 5: beef tripe in broth with chile. 6: includes tacos, *sopes*, *pellizcadas*, *gorditas*, *tostadas*, *peneques*. 8: maize flour, occasionally sweetened and mixed with cacao, cinnamon, or anise. 9: includes orange, mandarin, grapefruit, lemon, lime. 10: refers to the avocado fruit. 11: fermented *maguey* drink. 12: fermented maize drink. 13: water blended with fruit/flowers and sugar. 14: fermented maize drink. 15: includes bee, ant, wasp, maize, *maguey*, and *nopal* honey. 16: sweet bread, a traditional pastry prepared with sugar and fat. 17: including *chinocuil*. 18: also known as *chicatanas* and *escamoles*. 19: water-fly. 20: *axayacatl* (water-fly) eggs.

## 2.4. Amounts of Food Groups Included in the Traditional Mexican Diet

There was high heterogeneity regarding the quantities of the foods in the diet reported in the literature. While many studies reported maize ( $n = 38$ ), beans ( $n = 32$ ), *chile* ( $n = 24$ ), and squash ( $n = 20$ ) as basic items of the diet and animal foods ( $n = 9$ ) as limited items, establishing specific amounts of these items is essential when defining a dietary pattern, especially if this pattern is to be studied in relation to health [19]. This heterogeneity could have been the result of the inclusion in this review of different studies, which used different methods to describe the TMexD. Some authors reported amounts of food groups using percentages of contribution to the TEI, while others used frequencies and quantities consumed per week, all of which resulted in non-comparable outcomes. For example, when foods are assessed using percentages of contribution to the TEI, the results often depend on the energy density of the food evaluated [44][45]. That is, foods with lower energy densities such as fruits, vegetables, and herbs contribute less to the diet, even if they are consumed frequently or in large quantities. Further heterogeneity can be introduced when dietary patterns are derived using a posteriori analyses, as researchers might group the foods included differently [3] (e.g., grouping all maize products into one category or grouping them separately). As such, defining the amounts of foods that characterise the TMexD requires further examination. Future studies should refine the current diet definition results in order to establish a more concise and quantitative description of the TMexD, which might need to be specific to the target population (e.g., adults). The amounts of the food groups included in the TMexD might be more appropriately defined using frequencies and quantities, in order to avoid basing the food amounts on the energy density that these provide and allow easier interpretation by the public.

## 3. Association between the Traditional Mexican Diet and Non-Communicable Disease Outcomes

This study also summarised the current evidence relating the TMexD with NCD health outcomes. Given that most (83%) of the studies evaluated in this review were observational and given the possible risk of bias in some of the domains evaluated, it was not possible to reach strong conclusions on the health outcomes associated with adherence to the TMexD. Based on this evidence, the TMexD was inversely but weakly associated with breast cancer risk [46] but not related to blood triglyceride levels [47]. The associations with obesity and diabetes-related outcomes were inconsistent. In cross-sectional studies, the TMexD was associated with a reduced risk for being obese [48] but not with differences in BMI and WC [49]. Similarly, for the diabetes outcomes, high adherence to the TMexD was associated with lower insulin concentrations [47][50] and with a lower risk of having pre-diabetes in observational studies [51], but not with glucose levels (in either the cohort study or the RCT) [47][50]. Likewise, the changes in HOMA-IR and insulin biomarkers (i.e., IGF-1, IGFBP-3, IGF-1:IGFBP-3) in adults following a TMexD were inconsistent in the RCT [50] and in the cohort study [47]. However, these insulin biomarkers might only provide information about insulin resistance in obese individuals [52]; thus, they might not provide reliable information on diabetes outcomes. As such, all these results must be interpreted with

caution, especially since only a small number of studies measured the same outcomes, and most used a different definition of the TMexD, limiting the ability to compare results [49].

However, the TMexD, as identified in the present study, could potentially be considered a healthy dietary pattern. While the amounts of the foods included in the TMexD were inconclusive, which is essential to characterise a dietary pattern as healthy or unhealthy, the identified TMexD possesses some similarities with public health guidelines [53]. The TMexD is potentially high in fibre, as it contains grains, legumes, and fruits and vegetables. High fibre intakes have been consistently inversely associated with some obesity- and diabetes-related outcomes (i.e., BMI, body fat, fasting glucose, and fasting insulin) [54], colon cancer [55][56], and cardiovascular disease [57]. The TMexD is also potentially high in antioxidants, provided by fruits, vegetables, and some legumes and seeds [58][53], which have been associated with a reduced risk of developing cardiovascular diseases and cancer [59]. While the TMexD might also contain meats and animal products, sugars, and caloric beverages, which have been discouraged in the literature, these can still be part of a healthy diet, especially if these are consumed in small quantities [60]. However, more research is needed to evaluate the proportions in which these foods are present in the TMexD before producing high-quality evidence of the TMexD's association with health outcomes. Future studies could also evaluate the importance of traditional Mexican food preparation methods on NCD-related outcomes, as different preparations (i.e., different ingredients and cooking methods) can lead to different content in fibre, water, fat, and sugar, all of which could be relevant to foods' energy density [61][62]. It could also be important to identify the traditional dishes that contain an appropriate nutrient composition. Then, food preparations that are most in line with dietary recommendations and that promote health the most might be recommended over other preparations.

Future studies should use the current TMexD definition results and define the proportions in which these foods are present in the Mexican diet, preferably in the form of a dietary index. Then, an authentic Mexican diet, rather than a subjectively defined diet (i.e., using a *posteriori* analyses), could be examined with regard to its role in health outcomes. As previously discussed, although some TMexD indices [47] and quantitative recommendations [63] already exist, these might be complemented with some key items in the Mexican diet identified in the present study. For example, given the high presence of herbs and condiments in the TMexD, these might need to be evaluated separately, as they not only provide antioxidants to the diet [22], but also improve the palatability of different foods and meals [64][65]. Likewise, more research is needed to establish whether beverages and more 'unhealthy' items, such as processed foods, could be included in limited amounts in the definition of the TMexD, particularly as these have been recently included in the Mexican diet.

## **4. Conclusions**

The present work systematically reviewed the evidence, for the first time, to establish the definition of the TMexD and evaluate its relationship with NCD outcomes. By conducting a systematic review of the literature, we provided a comprehensive description of this diet and evaluated the foods consistently characterised as traditional Mexican. The findings suggest that the TMexD is composed of grains, legumes, and vegetables, while specific food items include mainly maize, beans, and *chile*. Additionally, maize products, fruits, beverages, fish and seafood, meats, sweets and sweeteners, and herbs and condiments might still play an important role in the TMexD, although these might be considered complementary to the previously mentioned foods. The inclusion of oils and fats and nuts and seeds could still also be considered when defining the TMexD, as these items were still mentioned, even if infrequently. However, if the aim is to promote the TMexD as a public health strategy, more research is needed to evaluate the feasibility of including some foods that are not usually consumed by the general population (i.e., insects and reptiles, or some meats and plant-based foods that are no longer common in Mexico) and foods that were more recent inclusions to the Mexican diet (i.e., eggs, dairy, and processed foods).

Findings regarding the TMexD's association with health outcomes should be interpreted with caution. While we reported the findings following standard guidelines and evaluated the studies' risk of bias and quality of reporting, the small number of studies, the high degree of heterogeneity between the studies included, the potential risk of bias in some studies, and the different TMexD definitions used hindered reaching strong conclusions on whether the TMexD is associated with health outcomes.

Nevertheless, the current findings provide a detailed description of the TMexD, which could be used as a reference to promote the ingredients contained in a TMexD or as a reference to evaluate this traditional diet's association with NCD outcomes. However, the present definition is limited by the lack of specific amounts in which these foods are consumed in the TMexD, particularly if the health properties of this diet are to be assessed. Elucidating the TMexD and operationalising

it in the form of a dietary index would allow more robust associations with health outcomes to be established in future research, with potentially important implications for NCD prevention in Mexico.

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