The impact of social determinants and lifestyles on dietary patterns during pregnancy: evidence from the “Mamma & Bambino” study

A. Maugeri¹, M. Barchitta¹, O. Agrifoglio¹, G. Favara¹, C. La Mastra¹, M.C. La Rosa¹, R. Magnano San Lio¹, M. Panella², A. Cianci², A. Agodi¹

Key words: Diet, dietary habits, foods, educational level, smoking, body mass index
Parole chiave: Dieta, abitudini alimentari, cibi, livello di istruzione, fumo, indice di massa corporea

Abstract

Background. During pregnancy, maternal dietary patterns play a critical role in determining maternal and newborn health. Recent evidence highlighted the influence of either social determinants and lifestyles on the adherence to different dietary patterns.

Study Design. In this cross-sectional analysis, we evaluated the association of social determinants and lifestyles with maternal dietary patterns in the “Mother & Child” cohort, a prospective study that enrols mother-child pairs from Catania, Italy.

Methods. Dietary patterns were derived using Food Frequency Questionnaire and Principal Component Analysis. Logistic regression models were used to evaluate the association between socio-demographic factors (i.e., age, educational level and employment status), lifestyles (i.e., smoking status, body mass index, use of folic acid, multivitamin and multi-mineral supplements) and dietary patterns.

Results. Overall, 332 women were enrolled and the following dietary patterns were derived: the “western” dietary pattern, characterized by high intake of red meat, fries, dipping sauces, salty snacks and alcoholic drinks; the second one, named “prudent”, characterized by high intake of potatoes, raw and cooked vegetables, legumes, rice and soup. Multivariable analysis showed that young age, low educational level and smoking were positively associated with the adherence to the western dietary pattern. In contrast, pregestational body mass index was negatively associated with the adherence to the prudent dietary pattern.

Conclusions. Our results raise the need of strategies for promoting healthy dietary habits among women in their reproductive age, which might also help control their body weight before and during pregnancy. These strategies should be prioritized to young women of low educational level, who generally share other unhealthy behaviours.

Introduction

Nutrition in women of childbearing age plays a critical role in determining maternal and infant health. During the preconception, perinatal and breastfeeding periods, a well-balanced diet, which supplies the body with the right amount of nutrients, is essential for promoting optimal fetal and neonatal development (1, 2). In contrast, unhealthy food choices - for instance, a low-energy and low-protein diet with inadequate nutrient intakes - lead to maternal nutrient deficiencies and infant low birth weight.

¹ Department of Medical and Surgical Sciences and Advanced Technologies “GF Ingrassia”, University of Catania, Italy
² Department of General Surgery and Medical-Surgical Specialties, University of Catania, Italy
(LBW) (3, 4). Given the importance of this issue, previous studies investigated the relationships of socio-demographic factors and other lifestyles with dietary intakes of foods and nutrients in women of childbearing age (5-11). Accordingly, most of the current nutritional recommendations against adverse pregnancy outcomes concern specific foods, food groups or nutrients (6). Although scientifically and physiologically relevant, the single food/nutrient approach is inadequate to explain several dietary effects on health, since it does not reflect the manner in which most individuals select and consume foods. Preventive strategies tackling the risk of adverse pregnancy outcomes in women of childbearing age should be based on the promotion of healthy dietary patterns, rather than on single nutrients or food groups. This is pushing the research towards the understanding of the joint contributions and interactions of foods that characterize specific dietary patterns. Dietary patterns can be identified by a priori methods, which explore the data using predefined combinations of foods in a dietary index, such as the Mediterranean diet score or the healthy eating index (12). A posteriori approaches, instead, explore the available data post hoc by either cluster or factor analysis, producing dietary patterns in which nutritional variables are reduced to a smaller number of variables (12). Among these, principal component analysis (PCA) is a frequently used exploratory method to derive dietary patterns in a population (13). Dietary and food pattern variables are based on the correlation matrix of the original food variables and individuals receive a factor score for each of the derived factors. This method reflects food components interactions and improves the capacity to investigate the effects of diet on health (13). In general, elderly and wealthy people lead a healthier lifestyle than their counterpart (14, 15). Similarly, non-smokers follow dietary recommendations better than smokers (11).

Despite of recommendations, maternal dietary habits seem to be influenced by socio-demographic and behavioral factors (i.e., socio-economic status, educational level, employment status and smoking habits) similar to general populations (7, 10, 14, 16). Mounting evidence showed that maternal food choices are affected by age, educational level and smoking habits in several populations (5-11). The latter, along with parity and body mass index (BMI), have been also associated with the use of supplements in European populations (17). Although this topic of research has been already addressed by previous studies worldwide, a posteriori dietary patterns have been also used as a proxy for a variety of factors that influence how individuals consume foods, including social, cultural and financial contributors (8, 18, 19). To our knowledge, current findings from the Mediterranean populations are scarce, raising the need of robust evidence for both Public Health professionals and the scientific community. In this cross-sectional analysis, we evaluated the association of social determinants and lifestyles with maternal dietary patterns in the “Mamma & Bambino” cohort, an ongoing prospective study that recruits mother-child pairs from Catania, Italy.

Materials and methods

Study design

The “Mamma & Bambino” (“Mother & Child”, in English) study is an ongoing prospective cohort that recruits pregnant women referred to the Azienda Ospedaliera Universitaria “Policlinico-Vittorio Emanuele” (Catania, Italy) for the prenatal genetic counselling. Extended information about study design and protocols can be found at http://www.birthcohorts.net and elsewhere (20). The study protocol was approved by the ethics committee of the
Determinants of maternal dietary patterns

Involved institution (CE Catania 2; Prot. N. 227/BE and 275/BE) and performed according to the Declaration of Helsinki. All women were fully informed of the purpose and procedures and gave written informed consent. To date, the “Mamma & Bambino” cohort has recruited 332 mothers without pre-existing medical conditions (i.e., autoimmune and/or chronic diseases) and/or pregnancy complications (i.e., preeclampsia, gestational hypertension and diabetes).

Assessment of socio-demographic and lifestyle characteristics

An ad hoc questionnaire was administered by trained epidemiologists to collect data on socio-demographic characteristics, lifestyle factors and the use of supplements. Education was categorized as low–medium (≤8 years of school) or high educational level (>8 years of school). With regard to employment status, mothers were classified as employed (including full-time and part-time workers) or unemployed (including students and housewives). Women were also classified as current smokers or non-smokers (including former smokers). Self-reported maternal pre-pregnancy weight and height were collected at the recruitment and pre-pregnancy BMI was calculated as weight in kilograms divided by height in meters squared, according to the World Health Organization criteria (21). Women were also asked to report their habitual use of folic acid, multi-vitamin and/or multi-mineral supplements.

Dietary data assessment

Dietary data, referred to the month preceding the recruitment, were obtained by a 95-item semi-quantitative Food Frequency Questionnaire (FFQ) (2, 22). For each food item, women reported the frequency of consumption (i.e. twelve categories from “almost never” to “two or more times a day”) and portion size (i.e. small, medium, and large using an indicative photograph atlas). Dietary data were further converted into monthly and daily food intakes, multiplying the frequency of consumption for the portion size (g). Total energy intake was calculated using the table of food composition of the US Department of Agriculture (http://ndb.nal.usda.gov), adapted to the typical Italian food consumption and food intakes were adjusted for total energy intake using the residual method (23).

Principal component analysis

PCA is one of the most commonly used exploratory method to derive dietary patterns (13), which are derived on the basis of the correlation matrix of predefined food groups. Based on the similarity of nutrient profiles or culinary usage, we first classified the 95 FFQ food items into 39 predefined food groups; individual food items were maintained if they constituted a distinct item on their own (e.g., eggs, pizza, coffee or tea, etc.) or if they characterized a particular dietary pattern (e.g., wine, alcoholic drinks, and fries, etc.). A posteriori dietary patterns were derived using the PCA followed by Varimax rotation on energy-adjusted food intakes, as described elsewhere (22, 24). The number of dietary patterns to retain was determined according to scree plot examination, eigenvalues >2.0 and interpretability. Factor loadings with an absolute value ≥0.25 were used to define food groups that characterized each dietary pattern. Women received a factor score for each of the derived factor, that indicated their adherence to each dietary pattern. Factor scores were calculated as the sum of products between the energy-adjusted food group intakes and their factor loadings. Adherence to each dietary pattern was classified as low (1st tertile), medium (2nd tertile) and high (3rd tertile) adherence, based on the distribution of factor scores.

Statistical analysis

Descriptive statistics were used to characterize the population characteristics
using frequency, median and interquartile range (IQR). Prior to analysis, the normal distribution of continuous variables was checked using the Kolmogorov-Smirnov test. Skewed variables (i.e., age and pre-gestational BMI) were compared using the Kruskal-Wallis test for comparisons between three groups. Categorical variables (i.e., educational level, employment status, smoking status, use of folic acid supplements and use of multi-vitamin and/or multi-mineral supplements) were compared using Chi-squared test. Logistic regression models were used to investigate the association of population characteristics (i.e., age, education level, employment status, smoking, pre-gestational BMI, use of folic acid supplements and use of multi-vitamin and/or multi-mineral supplements) with high adherence to each dietary pattern (3rd tertile vs. 1st and 2nd tertiles).

Statistical analyses were performed using SPSS software (version 22.0, SPSS, Chicago, IL, USA) and all p-values < 0.05 were considered statistically significant.

Results

Population characteristics

The current cross-sectional study analysed 332 women of the “Mamma & Bambino” cohort (median age: 37 years; range: 15-50 years), recruited at a median gestational age of 16 weeks (range: 4-20 weeks). In general, 19.3% and 41.9% women were less-educated and unemployed, respectively, whereas 20.3% of them were current smokers. According to pre-gestational BMI (median: 22.7 Kg/m2), women were classified as underweight (6.9%), normal weight (66.5%), overweight (17.2%) or

Figure 1- Radar graph of factor loadings characterizing each dietary pattern
Red line represents the distribution of factor loadings related to the western dietary pattern. Green line represents the distribution of factor loadings related to the prudent dietary pattern.
obese (9.4%). While the majority of women used folic acid supplements (94.9%), nearly 39.1% reported the use of multi-vitamin or multi-mineral supplements.

**Dietary patterns**

We derived two dietary patterns with eigenvalues >2.0 that explained 15.6% of total variance among the 39 food groups. Figure 1 shows factor loadings retained to characterize each dietary pattern: the first dietary pattern, named “western”, was characterized by high intake of red meat, fries, dipping sauces, salty snacks and alcoholic drinks; the second dietary pattern, named “prudent”, was characterized by high intake of potatoes, raw and cooked vegetables, legumes, rice and soup.

The association of socio-demographic characteristics and lifestyle with dietary patterns

Table 1 displays that women with high adherence to the western dietary pattern were younger and less-educated, compared with those who reported low or medium adherence (p <0.001 and p = 0.022, respectively). In contrast, the high adherence to the prudent dietary pattern was associated with higher folic acid supplementation and lower pre-gestational BMI than low or medium adherence (p = 0.033 and p = 0.019, respectively). Results from the logistic regression model (Table 2) confirmed that high adherence to the western dietary pattern was negatively associated with age (OR = 0.885; 95%CI = 0.829-0.945; p = 0.001)

<table>
<thead>
<tr>
<th>Population characteristics</th>
<th>Western dietary pattern</th>
<th>Prudent dietary pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1\textsuperscript{st}tertile</td>
<td>2\textsuperscript{nd}tertile</td>
</tr>
<tr>
<td>Age, years\textsuperscript{*}</td>
<td>38.0 (4.0)</td>
<td>38.0 (4.0)</td>
</tr>
<tr>
<td>Gestational age, weeks\textsuperscript{*}</td>
<td>14.7 (4.0)</td>
<td>16.0 (5.0)</td>
</tr>
<tr>
<td>Educational level, % of low-medium</td>
<td>20.0%</td>
<td>11.7%</td>
</tr>
<tr>
<td>Employment status, % of unemployed</td>
<td>40.9%</td>
<td>36.9%</td>
</tr>
<tr>
<td>Smoking status, % of current smokers</td>
<td>20.9%</td>
<td>18.0%</td>
</tr>
<tr>
<td>Use of folic acid supplements, % of users</td>
<td>94.5%</td>
<td>95.5%</td>
</tr>
<tr>
<td>Use of multi-vitamins or multi-minerals, % of users</td>
<td>40.7%</td>
<td>35.1%</td>
</tr>
<tr>
<td>Pre-gestational BMI, kg/m\textsuperscript{2}\textsuperscript{*}</td>
<td>22.5 (4.9)</td>
<td>22.7 (5.1)</td>
</tr>
</tbody>
</table>

Pre-gestational BMI, WHO categories

- Underweight: 7.3% 7.2% 6.4% 5.5% 8.1% 7.3%
- Normal weight: 63.6% 69.4% 66.1% 64.5% 65.8% 68.6% 0.575
- Overweight: 17.3% 13.5% 21.1% 20.9% 13.5% 17.4%
- Obese: 11.8% 9.9% 6.4% 9.1% 12.6% 6.4%

\textsuperscript{*}Results are reported as median (Interquartile range)

Significant p-values are in bold font

Abbreviations: BMI, body mass index; WHO, World Health Organization
and positively with low educational level and smoking (OR=1.617; 95%CI= 1.006-3.374; p=0.047 and OR=1.812; 95%CI= 1.004-3.269; p=0.048, respectively). In contrast, we confirmed a negative association between pre-gestational BMI and the prudent dietary pattern (OR= 0.920; 95%CI= 0.865-0.978; p=0.007). However, no associations of socio-demographic characteristics and lifestyles with the prudent dietary pattern were evident.

Discussion

To our knowledge, the present study is the first evaluating the relationships between a posteriori dietary patterns, social determinants and lifestyles in pregnant women from the Mediterranean area. We identified two dietary patterns in pregnant women from the “Mamma & Bambino” cohort, an ongoing prospective study exploring the effect of preconception, perinatal and early life exposure on maternal and infant health (25-29). The first dietary pattern - named “western” - was characterized by high intake of red meat, junk foods and alcoholic drinks; the second one - named “prudent” according to the well-accepted term in this field of research (22, 24) - was rich in vegetables. These dietary patterns are consistent with those described by Chen et al. in a recent review of studies on the relationship between maternal dietary patterns and pregnancy outcomes (30). Previous lines of evidence suggested that the high adherence to “western” dietary patterns was associated with adverse maternal and infant outcomes, including gestational diabetes mellitus (31), preterm birth (32) and reduced birth length (32). However, no associations with hypertension (33) and early foetal growth (34) have been established.

In our cohort, young women with low educational level adhered more to the “western” dietary pattern. This partially supports previous evidence that healthy food choices are more common among old women with higher educational level (5, 6), though we demonstrated no association of socio-demographic characteristics and lifestyles with the prudent dietary pattern were evident.

Table 2 - Logistic regression analysis of the association between population characteristics and high adherence to dietary patterns

<table>
<thead>
<tr>
<th>Population characteristics</th>
<th>Western Dietary Pattern</th>
<th>Prudent Dietary Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR 95% CI</td>
<td>p-value</td>
</tr>
<tr>
<td>Age (continuous)</td>
<td>0.885 0.829-0.945</td>
<td>0.001</td>
</tr>
<tr>
<td>Pre-gestational BMI (continuous)</td>
<td>1.002 0.950-1.056</td>
<td>0.947</td>
</tr>
<tr>
<td>Educational level (low-medium)</td>
<td>1.617 1.006-3.374</td>
<td>0.047</td>
</tr>
<tr>
<td>Employment status (unemployed)</td>
<td>1.066 0.635-1.792</td>
<td>0.808</td>
</tr>
<tr>
<td>Smoking status (current smokers)</td>
<td>1.812 1.004-3.269</td>
<td>0.048</td>
</tr>
<tr>
<td>Use of folic acid supplements (users)</td>
<td>0.917 0.422-1.996</td>
<td>0.828</td>
</tr>
<tr>
<td>Use of multivitamin supplements (users)</td>
<td>0.782 0.472-1.296</td>
<td>0.340</td>
</tr>
</tbody>
</table>

Significant p-values are in bold font

Abbreviations: BMI, body mass index
about maternal and child health, and pay more attention to their dietary quality.

In line with previous studies (11, 35), we also found differences in dietary habits between current and non-smokers. Of note, the adherence to the western dietary pattern was positively associated with smoking status, even adjusting for socio-demographic factors. Generally, non-smokers follow dietary recommendations better than smokers, while who smoke tend to have unhealthier dietary habits than former- or non-smokers (11). Although the reasons of different food choices between smokers and non-smokers are still unclear, there are two possible explanations: an attenuation of the senses of smell and taste due to smoking, and a more unhealthy lifestyle among smokers (36, 37).

Overall, we highlight the relevance of investigating the relationships of dietary patterns, socio-demographic factors and lifestyles during the peri-conceptional period. However, our study has some limitations including the cross-sectional design, which does not allow us to demonstrate the causality of the relationships. Furthermore, dietary assessment was referred to the first month of gestation and we were not able to account for changes in maternal dietary habits during pregnancy.

Finally, we cannot rule out the possibility of residual bias from unmeasured factors and confounders that might affect social determinants, lifestyles and maternal dietary patterns. To achieve the objectives of the “Mamma & Bambino” study, further research will be also directed to uncover the complex relationship between healthy/unhealthy lifestyles and adverse outcomes in both mother and child, with a focus on the previously proposed role of gene-diet interaction (2, 20, 38) and epigenetic mechanisms (26-29, 39, 40).

In conclusion, our results raise the need of strategies for the promotion of healthy dietary habits among women of reproductive age, which might help to control their body weight before and during pregnancy. These strategies should be targeted to young women of low educational level, who generally share other unhealthy behaviours.

Riassunto

L’impatto dei determinanti sociali e degli stili di vita sui profili nutrizionali in gravidanza: evidenze dallo studio “Mamma & Bambino”

Introduzione. Durante la gravidanza, la dieta materna ricopre un ruolo critico sia per la salute delle madri stesse che dei nascituri. Recent evidence hanno evidenziato l’influenza dei determinanti sociali e degli stili di vita sull’aderenza a diversi profili nutrizionali.

Disegno dello studio. In questo studio cross-sectional è stata valutata l’associazione tra determinanti sociali, stili di vita associati e profili nutrizionali materni nella coorte “Mamma & Bambino”, uno studio prospettico che arruole coppie mamma-bambino di Catania.

Metodi. I profili nutrizionali sono stati determinati mediante Food Frequency Questionnaire e Principal Component Analysis. Modelli di regressione logistica sono stati utilizzati per valutare l’associazione tra fattori socio-demografici (età, livello di istruzione e condizione lavorativa), stili di vita (abitudine al fumo, body mass index, uso di integratori di acido folico e/o multi-vitaminici) ed i profili nutrizionali.

Risultati. Sono state reclutate 332 donne ed identificati due profili nutrizionali così definiti: “occidentale”, caratterizzato dal consumo di patatine fritte, salse, snack e carne rossa, liquori ed altri drink; “prudente”, caratterizzato dal consumo di legumi, minestrone, vegetali cotti e riso. L’analisi multivariata ha mostrato che la giovane età, un basso livello di istruzione e l’abitudine al fumo sono positivamente associati ad una maggiore aderenza al profilo “occidentale. Un minore body mass index, invece, è associato ad una maggiore aderenza al profilo “prudente”.

Conclusioni. I nostri risultati sottolineano la necessità di strategie per la promozione di abitudini alimentari sane tra le donne in età riproduttiva, che potrebbe aiutare il controllo del peso prima e nel corso della gravidanza. Queste strategie dovrebbero essere indirizzate soprattutto nei confronti delle donne giovani con un basso livello di istruzione, che generalmente mostrano uno stile di vita complessivamente poco sano.

References

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Corresponding Author: Prof. Antonella Agodi, Department of Medical and Surgical Sciences and Advanced Technologies “GF Ingrassia”, University of Catania, Via S. Sofia, 87, 95123 Catania, Italy
e-mail: agodia@unict.it