Ann Ig 2015; 27: 646-656 doi:10.7416/ai.2015.2056

Feasibility and reliability of a questionnaire for evaluation of the exposure to indoor and outdoor air pollutants, diet and physical activity in 6-8-year-old children

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Key words: Food-frequency questionnaire, repeatability, reliability, children
Parole chiave: Questionario sui consumi alimentari, ripetibilità, affidabilità, bambini

Abstract

Introduction: *The MAPEC-Life project aims to study the biological effects of early exposure to air pollutants on the oral mucosa cells of school-age children in five Italian cities. A questionnaire was created to evaluate the association between outdoor and indoor airborne pollutants, lifestyle, diet and biomarker effects. The feasibility and reliability of the questionnaire were evaluated.*

Methods: *A questionnaire was drawn up to be filled in by the parents of 6-8-year-old children. It consisted of 148 questions on the children's health, physical activity, environmental exposures and the frequency of food consumption at the main meals.*

First we conducted a questionnaire feasibility study involving 53 volunteer parents. We then performed a reliability study by administering the questionnaire to a further 156 parents and again one month later (test/retest method).

The correlations between answers at the first and second administration of the questionnaire were evaluated using the Kappa statistic and Spearman's coefficient.

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Results: *After verifying the feasibility of the questionnaire, we conducted a reliability analysis on 132 completed questionnaires. The percentage of agreement between the first and the second responses given was over 70%, all K values being greater than 0.6. The analysis of calories and macronutrients also showed good agreement.*

Conclusions: *The questionnaire drawn up for the study proved to be sufficiently reliable for gathering information about the factors of interest in our study of the relationship between air pollution and early biological effects in children.*

Introduction

The MAPEC-Life project (Monitoring Air Pollution Effects on Children for Supporting Public Health Policy), which is funded by the European Commission as part of the LIFE+ Program, the EU environment fund, consists of a multicentre cohort study. The study protocol is reported in Feretti et al. (1) and is outlined below. The study lasts for three years, the aim being to evaluate the association between the levels of some air pollutants, such as PM10 and PM0.5, nitrogen oxides, polycyclic aromatic hydrocarbons (PAHs) and nitro PAH, and early biological effects in buccal cells of children aged 6-8 years. To this end 1000 children will be recruited in 5 Italian towns with different air pollution levels (Brescia, Lecce, Perugia, Pisa and Turin). The environmental and biological samples will be collected in two different seasons (winter and late spring) to allow a better evaluation of seasonal differences in pollution.

Early biological damage to leukocytes of biological samples will be evaluated using the Comet assay (2). Micronuclei frequency will be evaluated in buccal mucosa cells (3). These tests provide data on early genotoxic damage and have been used, in vivo and in vitro, in various occupational and biomonitoring population studies (2-5).

It is common knowledge that an evaluation of the biological effects of outdoor pollutants requires other sources of exposure, such as secondary smoke and the use of fireplaces and wood stoves in the domestic environment, to be taken into account. Diet also appears to modulate the organism's response to environmental pollution (2-5). Several studies have shown that diet can influence the response to the biological effects of different biomarkers, such as micronuclei in different cells (6-11).

Bonassi et al. showed that the mean frequency of micronuclei in buccal mucosa cells of subjects with a mean age of 35.5 ±7.7 years who ate fruit and leafy green vegetables daily was lower than in subjects that did not eat fruit or vegetables (11). One recent study found an inverse correlation between micronuclei frequency in lymphocytes and mucosa cells and the intake of vitamins with redox activity (12).

As far as we know there are no standardized questionnaires for collecting data about air pollution exposures and diet in primary school children enrolled in the MAPEC-Life study, so we created an *ad hoc* questionnaire to evaluate the association between (outdoor and indoor) environmental exposures and other environmental parameters.

The aim of this study was to examine the feasibility and reliability of the questionnaire developed to evaluate exposure to indoor and outdoor air pollutants, diet and physical activity in 6-8-year-old children.

Methods

Creation of the questionnaire

We created a self-administered questionnaire to be filled in by the parents of the children enrolled in the study. It was designed to include items on demographic

and socio-economic variables, and exposures to indoor and outdoor sources of air pollution, and it was based on a questionnaire used in a previous study performed in Brescia on pre-school children (aged 3-5 years) to evaluate their exposure to air pollution and early biological effects (13).

The first section of the questionnaire listed the study exclusion criteria: residence in a town not included in the study, children not in the age range 6-8 years, serious diseases such as tumours and some genetic diseases, consumption of certain drugs, undergoing radiography during the preceding month and use of orthodontic devices. The child was excluded from the study if a positive response was given to one or more of the questions.

The questionnaire was divided into 6 sections: personal details, characteristics of the home (e.g. traffic situation, heating systems, fireplace and/or wood); traffic near the school, the child's general health, physical activity and other aspects of their lifestyle; second-hand smoke exposure at home; parents' characteristics (education, work, smoking habit) and diet.

The diet section was based on the questionnaire used in the ARCA (Italian acronym: diet in the Campania region) project, which studied the diet and anthropometric index of children aged 5-10 years in Campania (14).

The ARCA questionnaire collected consumption frequencies for different foods and required respondents to rate the amount of each food consumed in one of three categories ("more than", "equal to" or "less than" the standard portion for an adult).

The amount of food consumed was not considered relevant for the purpose of the MAPEC-Life study, so questions on this matter were not included. The section only contained questions on the average frequency of food consumption in a specific season (winter or late spring, corresponding to the biological sampling periods) (1), the cooking method and the condiments used.

Foods were divided into the following groups: bread; pasta and cereals; pulses; vegetables; fruit; meat; fish; milk and dairy products; desserts and cakes; non-alcoholic beverages and sugar. There was also a short section on the type of fat (butter, olive oil, seed oil, margarine) used for preparing, cooking and dressing the food.

For each item respondents could choose between 7 different categories of consumption frequency, ranging from "1 or 2 times a day" to "less than once a week", and a "never" option was also included. Nine categories for drinks (other than water) were included, since it was assumed that several doses a day could be consumed.

The questions on food consumption frequencies considered all the children's meals throughout the day, those consumed both at home and out, in the school canteen for instance, and refer to the corresponding biological sampling season.

Data analysis

First, a questionnaire feasibility study was conducted. The questionnaire was administered to an opportunity sample of parents of children aged 6-8 years enrolled in the 5 towns participating in the project. After compilation, the subjects were asked to indicate whether the questions were clear as to their content, whether they had any problems or doubts as to the answers, and whether any questions could be considered offensive or invaded their privacy. Lastly, they were asked to indicate the time taken to complete the questionnaire. A space was provided for respondents to leave comments and/or suggestions concerning the questionnaire. The data collected during this first phase underwent qualitative (descriptive) analysis only.

In order to assess the reliability of the questionnaire, we enrolled another opportunity sample of parents who had

not participated in the feasibility study and asked them to complete the questionnaire on two separate occasions, one month apart.

Agreement between the two interviews was assessed by computing Cohen's Kappa statistic (K) for dichotomous variables.

The data on food consumption frequency enabled us to calculate total energy load and diet composition in terms of micro and macro nutrients using NAF software developed by the Milan. Cancer Institute's Unit of Nutritional Epidemiology. This programme allows you to convert consumption frequency into amounts of nutrients in the diet, given a standard amount of food consumed per serving.

We then evaluated the correlation of the two sets of responses, including those to questions on energy intake and macro and micronutrients, as continuous variables, using Spearman's rho coefficient (r) for ordinal or continuous variables.

Results

Feasibility study

The first section of the questionnaire consisted of 6 questions on the criteria for inclusion. This was followed by a section on personal details, 32 questions on the child's environmental exposures, health condition and physical activity, and 116 questions relating to diet.

The compiling parent could choose to fill in the questionnaire either on-line, by invitation, or on a printed form. All the questions had closed answers.

A feasibility study was conducted after creation of the questionnaire. Fifty-three subjects were enrolled in five cities: 45 subjects provided completed questionnaires; 8 subjects were excluded due to the presence of one or more exclusion criteria (n = 5) or to failure to complete the questionnaire (n = 3).

Table 1 shows the 5 closed questions posed at the end of the questionnaire to

Table 1 - Feasibility study.

Feasibility study's questions	Number	Percentage %
With regard to content, the questions were		
Clear	42	93.3
Not very clear	3	6.7
Not at all clear	0	0
Were there any questions you had difficulty answering?		
no	39	86.7
yes*	6	13.3
Were there any upsetting questions you would have preferred not to answer?		
no	44	97.8
yes*	1	2.2
Did you find the questionnaire particularly long to complete?		
no	33	73.3
yes	12	26.7
Time taken to complete the questionnaire		
<10 minutes	2	4.4
10-20 minutes	25	55.6
21-40 minutes	11	24.4
>40 minutes	7	15.6

*If so, which questions?

assess their feasibility. In 93% of cases the questions were clear as to their content and 86% of the respondents said they had had no difficulty in answering. 55.6% of parents completed the questionnaire in 10-20 minutes and 24.4% in 21-40 minutes.

Three questions (out of 148) were reported as not being very clear. Therefore, based on the suggestions made, some minor revisions were made to the structure of these questions, some possible answers to the diet questions were expressed more clearly (Table 1) and the inclusion of specific foods under different items was clarified (e.g. it was specified that omelette had to be associated with the frequency of egg consumption).

Only one parent reported being offended by one of the questions, but it could not be changed as it concerned one of the exclusion criteria, namely the presence of genetic diseases in the children.

Reliability study

The second stage consisted of a questionnaire repeatability study, following the changes made as a result of the feasibility study. We enrolled 156 volunteer parents of children aged 6-8 years who met the inclusion criteria and had correctly completed the questionnaire the first time. Twenty-four of these subjects (15.4%) did not agree to complete the questionnaire re-administered one month later and were therefore excluded from the study. The analysis was therefore conducted on 132 completed questionnaires. Of the participating parents, 50.7% had male children (n = 67) and 49.3% had female children (n = 65). The majority of the parents were Italian, did not smoke and had at least a high school education (Table 2).

Table 3 shows the main questions in each section of the questionnaire, the percentage of agreement between the answers given the first and the second time, and the K value: agreement between the two interviews was generally high, above 70%, with a K value of over 0.6.

The agreement percentages were lower for responses concerning the frequency of consumption of various foods, probably due to the number of consumption frequency categories (seven) (Table 4). We computed an analysis of the responses regarding frequency of consumption by combining the categories and reducing them to 3 ("never," "sometimes," "every day"). The results showed higher agreement percentages and higher K values. For example, the consumption of breakfast cereals given in Table 4 shows 63.6% agreement between the answers the first and the second time, with a K value of 0.52. When the 7 categories of consumption were reduced to 3, the percentage of agreement increased to 77.2%, with a K value of 0.62, resulting from less data dispersion due to the presence of fewer answer options.

The analysis of calorie intake, carbohydrates and total lipids, and various macronutrients derived from the frequency reported in the responses showed a good agreement between the first and the second set of responses for each item, as shown in Table 5.

Discussion

The aim of the work was, by means of a feasibility and a repeatability study, to create and evaluate a tool for collecting data to analyse the association between environmental (outdoor and indoor) exposures, nutrition and other variables and some early biological effects and to examine the role of these factors confounding the biological effects of air pollutants on children.

Feasibility and repeatability studies were performed on a group of volunteers with children aged 6-8 years recruited in five Italian cities involved in the MAPEC-Life study.

The group of volunteers who took part in

Table 2 - Demographic and socio-economic characteristics and smoking habits of the 132 parents enrolled.

Characteristics	Number	Percentage %
Children		
males	67	50.7
females	65	49.3
Children's age		
6 years	42	31.8
7 years	35	26.5
8 years	20	15.2
9 years	35	26.5
Mother's nationality		
Italian	128	97.0
foreign	4	3.0
Mother's education		
middle school	10	7.6
high school	41	31.0
university	81	61.4
Mother's occupational status		
employed	106	80.3
unemployed	11	8.3
housewife	15	11.4
Mother's smoking habit		
yes	12	9.1
no	120	90.9
Father's nationality		
Italian	119	90.2
foreign	13	9.8
Father's educational status		
primary school	2	1.5
middle school	28	21.4
high school	53	39.7
university	49	37.4
Father's occupational status		
employed	122	92.4
unemployed	4	3.0
retired	6	4.6
Father's smoking habit		
yes	26	19.8
no	104	80.2

Table 3 - Agreement percentages and K values for the answers given to the main questions administered one month apart.

	Agreement between the first and second responses (%)	K value
Home section		
How do you rate the car traffic near your home?	84.9	0.75
Is there truck traffic near your home?	79.5	0.57
School section		
How do you rate the car traffic near the school?	75.0	0.63
Is there truck traffic near the school?	79.5	0.62
Lifestyle section		
Does your child play sport three or more times a week?	89.4	0.78
How many hours a day does your child play outdoors?	59.0	0.26
Does your child stay indoors with people who smoke?	99.2	0.79
Does your child stay in the kitchen while you are cooking?	81.8	0.64
Total consumption of foods that may contain genotoxic substances (e.g. polycyclic aromatic hydrocarbons)	79.5	0.51
Does the mother smoke?	100	1.0
If yes, how many cigarettes a day?	100	1.0
Does the father smoke?	100	1.0
If yes, how many cigarettes a day?	98.4	0.94

the study differed from the Italian general population in terms of demographic and socio-economic characteristics, as can be seen in Table 1.

The average percentage of children born in Italy with at least one foreign parent is 19% (15), while the percentage of foreign fathers in our sample was 9.8%, and the proportion of foreign mothers considerably lower (3.0%). Overall, the percentage of children in our sample with at least one foreign parent (12.8%) was lower than the national average (15). The level of education for both mothers and fathers was well above the national average (61.4% vs 27.2% graduate mothers in our sample and 37.4% vs 17.7% for graduate fathers, respectively). Furthermore, a comparison with the data for Italian female employment (51%) revealed that a much higher percentage of mothers (80%) in our sample were in employment (15).

Lastly, the sample showed a lower proportion of smokers (9% of mothers, 19.8% of fathers) compared to Italian percentages in the 35-45-year age bracket (24.5% of women, 35.4% of men) (15).

The collection of demographic data was necessary to allow a comparison with other Italian and international studies, such as the SIDRIA study, (acronym for "Italian studies on respiratory disorders of the child and the environment") and ISAAC - International Study on Asthma and Allergy in Children (16-17), which took demographic, socio-economic, family and lifestyle factors into account in their assessment of the relationship between respiratory diseases in children and air pollution.

The section on indoor and outdoor exposures in our questionnaire was based on other questionnaires widely used in similar projects, such as the SIDRIA-2 study (16). We also took into account the tool developed for a previous study conducted in Brescia on pre-school children aged 3-5 years, the purpose of

Table 4 - Percentages of agreement and K values of the answers on the frequency of consumption of the main food categories given in two questionnaires administered one month apart.

	Analysis of consumption in 7 categories (as appearing in the questionnaire)		Analysis of consumption in 3 categories ("never", "sometimes", "often")	
	Agreement between first and second answers %	K value	Agreement between first and second answers %	K value
Breakfast cereals	63.4	0.52	77.2	0.62
Pasta or rice	44.7	0.29	68.2	0.36
Pizza	68.9	0.44	96.2	0.27
Pulses	63.4	0.47	90.1	0.71
Lettuce and other salad items	56.8	0.43	78.8	0.60
Potatoes	62.8	0.40	94.7	0.60
Carrots	71.9	0.48	81.2	0.62
Oranges, tangerines, etc.	44.7	0.31	75.7	0.48
Apples and pears	51.2	0.38	78.9	0.51
Red meat	67.4	0.47	93.1	0.49
White meat	62.1	0.37	92.4	0.34
Sausages and cold cuts	63.6	0.42	85.6	0.49
Ham, mortadella, speck	62.1	0.44	87.1	0.51
Canned tuna	65.9	0.47	84.9	0.59
Fish fingers	74.2	0.60	87.8	0.71
Red snapper, sole, sea bream, sea bass, mullet, etc.	79.8	0.59	81.0	0.60
Eggs (including omelette)	75.0	0.54	99.2	0.91
Milk	75.0	0.58	84.5	0.73
Parmesan cheese	54.5	0.45	74.2	0.55
Yogurt	59.0	0.45	71.9	0.50
Biscuits	52.3	0.41	73.4	0.57
Buns and cakes	53.8	0.37	75.0	0.52
Packaged sweet snacks	76.5	0.55	76.5	0.55
Chocolate and chocolate-based snacks	46.2	0.30	76.5	0.43
Sweets	79.5	0.60	79.5	0.60
Chips and crisps	77.2	0.33	77.2	0.33
Fizzy drinks (e.g. coca cola)	68.2	0.55	84.8	0.65
Fruit juice	46.2	0.34	75.0	0.55
Do you use oil, butter or margarine in/with the following? *:				
Sauces and gravy	98.4	0.66	-	-
Baked food	93.9	0.65	-	-
Pan-cooked meat, fish and vegetables	98.1	0.37	-	-
Raw vegetables	99.4	-	-	-
Cooked vegetables	99.2	-	-	-
Homemade cakes and desserts	82.5	0.64	-	-

* Consider your normal use of oil, butter or margarine for cooking various different foods. There are no consumption categories.

Table 5 - Comparison of calorie and macronutrient intake obtained from the frequency reported in the two responses to the questionnaire given one month apart.

	Mean ± SD first response	Mean ± SD second response	Spearman's r
Energy intake (kcal/day)	2396.1 ± 643.1	2337.6 ± 755.7	0.73
Protein (g/day)	78.5 ± 21.9	77.3 ± 28.0	0.75
Sugar (g/day)	125.9 ± 51.8	120.4 ± 57.6	0.77
Total carbohydrates (g/day)	335.6 ± 99.6	323.7 ± 101.4	0.67
Total lipids (g/day)	95.5 ± 31.7	94.5 ± 39.7	0.70
Saturated fatty acids (g/day)	30.2 ± 10.2	30.5 ± 14.8	0.75
Fibre (g/day)	23.2 ± 9.5	21.8 ± 8.6	0.66
Water (ml/day)	1248.9 ± 487.0	1184.6 ± 467.3	0.76

which was to assess the association between air pollution and biological damage in oral mucosa cells (13).

As far as we know, standard questionnaires investigating the food consumption and dietary habits for children our age range (6-8 years) aren't currently available. Numerous studies have investigated the eating habits of children and adolescents, but for purposes other than those of the MAPEC-Life study; the information was normally used to evaluate some specific outcomes strongly correlated with food, such as obesity (14, 18).

In the MAPEC-Life study, food consumption in children has been studied as a possible confounding factor in the body's response to an environmental insult. For this reason, the final analysis considered both specific foods and food groups with a potentially genotoxic effect, such as grilled products, due to the possible presence of polycyclic aromatic hydrocarbons produced during cooking. Some studies have highlighted the protective role of the diet, especially certain nutrients and dietary supplements, in countering the biological effects of oxidative stress induced by exposure to air pollution (19-22).

The results of the feasibility study showed that the respondents found the questions clear, unambiguous and not offensive. Compilation times were also acceptable, about 85% of the subjects taking less than 40 minutes to answer all the questions.

The feasibility study showed an overall high level of comprehension of the questions and acceptable answer options.

The results of the repeatability study showed that all the responses had an acceptable level of repeatability, with high percentages of agreement for most of them.

In the diet questionnaire, the presence of numerous response categories regarding the frequency of food consumption led to a dispersion of the responses, and hence a reduction in the degree of agreement. When we reduced consumption to just three categories ("never", "sometimes", "every day"), the agreement between the responses, as shown by the higher K values, was satisfactory.

The results of our repeatability study are in line with those obtained recently by other food questionnaires (23-25).

The calculation of the amount of intake by food category, considering a standard serving, was also essentially in agreement with data from a national study conducted on children of the same age as those taken into account in this study (26).

The main limitation of the questionnaire is related to the lack of measures of validity. In a validation study, the questionnaire needs to be compared with a reference (gold standard). The validation of food

questionnaires would ideally require other means of measurement, such as a food diary or 24h recall questionnaire, but this would have taken up more time and resources than justified by the main objective of the MAPEC-Life project, namely to evaluate the association between the levels of the main environmental pollutants and some markers of early biological effects in oral mucosa cells of children.

A further consideration is that the good agreement between the two sets of responses given was due to remembering the answers given the first time round. This seems unlikely, however, given the large number of questions and the one-month interval between the first and the second administration. The good agreement obtained from the calculation of energy intake, which does not necessarily depend on the frequencies of consumption of the various foods, backs up the results of the reliability study.

Conclusions

In conclusion, we believe that the questionnaire created for the study is a useful tool for collecting data on possible confounding factors in the evaluation of the relationship between air pollution and early biological effects in children.

Riassunto

Fattibilità e ripetibilità di un questionario per la valutazione dell'esposizione ad inquinanti aerei outdoor e indoor, alimentazione e attività fisica in bambini di 6-8 anni

Introduzione: Il progetto MAPEC-Life si propone di studiare gli effetti biologici precoci da esposizione ad inquinanti atmosferici sulle cellule della mucosa orale di bambini in età scolare in 5 città italiane. Per valutare l'associazione tra esposizioni ad inquinanti aerodispersi, outdoor e indoor, stili di vita, abitudini alimentari e alcuni biomarcatori di effetto è stato costruito un questionario *ad hoc* e ne è stata valutata la fattibilità e l'affidabilità.

Metodi: Il questionario autocompilato dai genitori dei bambini comprende 148 domande riguardanti la salute, l'attività fisica dei bambini, le esposizioni ambientali e la frequenza di consumo degli alimenti nei principali pasti della giornata.

È stato *in primis* effettuato uno studio di fattibilità del questionario su 53 genitori volontari; successivamente è stato condotto uno studio di ripetibilità con doppia compilazione del questionario (tecnica del test re-test) a distanza di un mese su 156 soggetti. La concordanza delle risposte date alla 1a ed alla 2a somministrazione è stata valutata con la statistica Kappa e il coefficiente di Spearman.

Risultati: La fattibilità del questionario è risultata soddisfacente. L'analisi della ripetibilità è stata condotta su 132 questionari completi. La percentuale di accordo tra le risposte fornite nel 1° e nel 2° questionario è risultata mediamente maggiore al 70%, con kappa superiore a 0.6.

Conclusioni: Il questionario preparato è risultato fattibile ed affidabile per la raccolta di informazioni riguardanti diversi fattori di interesse nello studio della relazione tra inquinamento atmosferico ed effetti biologici precoci nei bambini.

Progetto finanziato dal Programma LIFE+2012 Environment Policy and Governance. LIFE12 ENV/IT/000614

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