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Association between household cleaning product profiles evaluated by the Ménag'Score® index and asthma symptoms among women from the SEPAGES Cohort

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Abstract

Objective Considering household disinfectants and cleaning products (HDCP) as mixture of ingredients, rather than each ingredient individually, might help in characterizing their role in asthma. We investigated the association between HDCP and asthma, using the recently developed Ménag'Score®, a health risk assessment score based on exhaustive ingredient lists of HDCP.

Methods The study is based on 103 female volunteers of the SEPAGES cohort (2014-2019), with repeated data (up to 3 collection times, 200 observations). HDCP use was assessed from a barcode-based smartphone application linked with an ingredient database. The Ménag'score® risks for health and environment were computed for each weekly used HDCP from their exhaustive ingredient data (from A: no known risk to E: highest risk). The association between the use of HDCP with a poor Ménag'score® (D or E; overall, health, environment scores) and asthma symptoms, was estimated by generalized estimating equations models adjusted for age, BMI and smoking status.

Results Participants were on average 33 years old, 11% smoked and 20% had at least one asthma symptom. The Ménag'score® was computed for 540 HDCP scanned by participants. Weekly use of HDCP with a poor Ménag'score®-health (around 60% of the participants) was associated with a higher risk of asthma symptoms (OR=3.13, 95%CI:[1.32-7.43]). No association was observed for the Ménag'score®-environment.

Conclusion The use of HDCP with a poor Ménag'score®-health was associated with asthma symptoms. The results support the use of the Ménag'score®-health to further evaluate the health risks of HDCP in observational studies and as a potential public health tool.

Statements and Declarations

Declaration of interest statement. The authors report there are no competing interests to declare.

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Ethical considerations. Ethics approval for the SEPAGES study was obtained from the *Comité de Protection des Personnes Sud-Est V* (approval number 13-CHUG-44). All Participants provided a signed informed consent form.

Data availability statement. The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request and with the permission of the SEPAGES Study group.

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Introduction

Disinfectants and cleaning products (DCP) have been consistently observed to have deleterious effects on asthma in adults either at work (Weinmann et al. 2019; Rosenman et al. 2020) or at home (Zock et al. 2007; Le Moual et al. 2012, 2014; Bédard et al. 2014; Matulonga et al. 2016; Weinmann et al. 2017; Lemire et al. 2020, 2021; Dumas et al. 2021). DCP are complex mixtures of ingredients, and their composition varies according to their forms (sprays, liquids, foams) and their purposes (multipurpose cleaning, kitchen surfaces, bathroom). Previous work suggests that some categories of DCP such as sprays, or disinfectants and some specific ingredients, such as Quaternary Ammonium Compounds (QAC), bleach, ammonia, or acids are associated with increased risks for respiratory health (Clausen et al. 2020; Hadrup et al. 2021). Precise biological mechanisms and causal agents are not yet elucidated but may involve irritant or sensitizing properties of HDCP ingredients (Archangelidi et al. 2020; Tarlo 2021). Exposure assessment with specific information on irritant or sensitized HDCP ingredients may open the opportunity to advance the understanding of the mechanisms underlying the effects of HDCP on asthma (De Matteis and Cullinan 2015).

Association studies considering DCP as mixtures of ingredients, rather than each ingredient individually, might help in characterizing the health impact of HDCP.

In previous studies, DCP used at home (HDCP) were mainly assessed through self-reported questionnaires (Zock et al. 2007; Le Moual et al. 2012, 2014; Bédard et al. 2014; Matulonga et al. 2016; Weinmann et al. 2017; Lemire et al. 2020; Dumas et al. 2021). In order to assess the joint effect of the use of multiple HDCP, some of them used statistical methods to identify exposure household cleaning patterns from questionnaire data (Le Moual et al. 2012; Bédard et al. 2014; Weinmann et al. 2017; Dumas et al. 2021). However, most participants do not know the specific compounds of their consumer products which may affect health risk estimates (Delclos et al. 2009; Lemire et al. 2021). To limit the impact of participants knowledge on the assessment of HDCP use, identifying products by the use of HDCP barcodes was suggested (Quinot et al. 2018; Lemire et al. 2021).

A barcode-based smartphone application (BC-App) linked to an ingredient database was developed as an objective tool to improve exposure assessment (Quinot et al. 2018; Lemire et al. 2021). This exposure assessment tool has recently been used in the SEPAGES cohort (Lemire et al. 2021), and the use of bleach-based or scented HDCP assessed by the BC-App was associated with a higher risk of

asthma symptoms (Lemire et al. 2021). This approach focused on some specific HDCP ingredients, and its refinement warrants further investigations.

The Ménag'score® ("Toxicological Cleaning score") is a five-level index, developed by scientists from the French National Institute for Consumption (INC), scoring each specific HDCP from A to E, respectively representing a low to a high risk for the health and the environment according to available scientific toxicological evidence (Institut National de la Consommation 2019a). Specifically, the Ménag'score® is the weighted sum of two risk categories: the Ménag'score®-health (70%) and the Ménag'score®–environment (30%). The Ménag'score® was constructed in a similar purpose as the Nutri-score, a front-of-pack nutrition label that focuses on being both easy-to-read for the public and based on scientific evidence (Chantal et al. 2017; Dréano-Trécant et al. 2020). It is considered as an effective tool to guide consumers towards healthier food choices by the international Agency for Research on Cancer from the World Health Organization (International Agency on Cancer 2021). The relevance of the Ménag'score® to identify HDCP associated with risk for respiratory health has not been evaluated yet.

We aimed to investigate the association between HDCP ingredient profiles, evaluated from the Ménag'score®-health, and the asthma symptom score. We hypothesized that a Ménag'score®–health graded D or E would be associated with a higher respiratory risk whereas no association is expected with the Ménag'score®–environment.

Material and methods

Study design and population

The SEPAGES (https://cohorte-sepages.fr) couple-child cohort has been set up in the Grenoble area (France) to assess the effects of environmental exposures on pregnancy outcomes and child health (Lyon-Caen et al. 2019). A total of 484 women were recruited during their first trimester of pregnancy between 2014 and 2017 as previously described (Lyon-Caen et al. 2019; Lemire et al. 2021). Briefly, women were approached when they were coming to their mandatory 13-week ultrasound examination at one of eight obstetrical ultrasonography practices located in the Grenoble area. Women were included according to the following eligibility criteria: living in the study area, older than 18 years old, being pregnant by less than 19 gestational weeks at inclusion, having a singleton pregnancy and planning to give birth in one of the four maternities clinics from Grenoble area. The eligibility rate was 69% and participation rate was

21%, using local birth certificates for the estimation. Questionnaires were used to collect socio-demographic and health data and, since January 2017, participants were invited by a fieldworker to use for a week a BC-App to collect HDCP use data. Participants answered respiratory questionnaires and used the BC-App at up to 3 data collection times: end of the first trimester of pregnancy (T1; 18 gestational weeks), during the third trimester of pregnancy (T3; 34 gestational weeks) and at two months or during the year after delivery (Y1) between 2017 and 2019.

Cleaning products use

Since 2017, 103 women used a BC-App during a week to assess HDCP at up to 3 different data collection times (T1, T3, and two months after delivery (Y1)) as described in details previously (Lemire et al. 2021). Data recorded through the BC-App was secondarily linked to a HDCP database, referencing exhaustive ingredients lists for each of the participants-scanned barcodes. The application used by the participants in the present study has already been described (Quinot et al. 2018; Lemire et al. 2021). Briefly, volunteers used the BC-App, preinstalled on a provided phone (Samsung Galaxy S3), over a week-long period. The BC-App let the participants identify each cleaning product used by scanning their barcodes and completing a short in-application questionnaire about their weekly frequency of use, form and commercial names. Ingredients lists of HDCP were obtained from a prospective barcode-ingredients database of commercially available HDCP as previously described (Lemire et al. 2021).

Asthma symptom score

Participants answered a respiratory health questionnaire administrated by a fieldworker during home visits at each data collection times (T1, T3, Y1). The asthma symptom score consists of the sum of positive answers to questions on five asthma-like symptoms reported in the last 12 months: (i) breathless while wheezing, (ii) woken up with a feeling of chest tightness, (iii) attack of shortness of breath at rest, (iv) attack of shortness of breath after exercise, (v) woken by attack of shortness of breath. Thus, 3 asthma symptom score were calculated: the first (T1) covering the year before the pregnancy, the second covering the whole pregnancy (T3) and the third (Y1) covering the year after delivery. The validity of the asthma symptom score has been evaluated in the European Community Respiratory Health Survey cohort. The asthma symptom score was considered to have a good predictive ability against asthma-related outcomes (incident asthma, asthma attacks, asthma treatment and bronchial hyperresponsiveness)

and a good ability to detect risk factors (Sunyer et al. 2007), and is now commonly used in the literature (Le Moual et al. 2012; Bédard et al. 2014; Rollins et al. 2020; Lemire et al. 2021). In the analysis, the asthma symptom score (range: 0 to 5) is considered in two classes (0 vs ≥1) given the low number of participants with asthma symptom score greater or equal to 2, as previously described (Lemire et al. 2021).

Ménag'score®

The National Institute of Consumption (INC) built a system of notation intended for evaluation of the environmental and sanitary risk for each HDCP: the Ménag'score® (Institut National de la Consommation 2019a, b). It is a five-level score graded from A to E, with A representing a product at low risk (provided it is used in accordance with the manufacturer's recommendations) and E representing a product at high risk (use strongly discouraged) for the environment or health. The exact calculation algorithm is currently confidential but is based on the general principles outlined in Figure 1.

Briefly, the principle of the Ménag'score® was to classify in a systematic and automatic way the household products according to their health and environmental impact. It relied on the exhaustive list of the ingredients of the HDCP available freely on the websites of the manufacturers following regulatory obligation (European Parliament and Council 2004), although we are not able to assess the manufacturers' commitment. For each ingredient, a health and environmental hazard level was assigned (from 1: lowest to 5: highest) for each notification of hazard according to the Classification, Labelling and Packaging (CLP) of chemical substances and mixtures (European Chemicals Agency (ECHA) (EU-OSHA 2021)). For each ingredient, the maximum health and environmental hazard levels were considered separately. For each ingredient, a coefficient was attributed to the hazard level depending on the product category, including the task and format of the product (for example, "kitchen and bathroom - decalcifier spray"), and linked to its position in the list of ingredients (the first position in the list corresponded to the ingredient with the highest concentration and the last position to the ingredient with the lowest concentration). For the environmental score, the position of the ingredient in the list (linked to its concentration level) of the ingredient was not considered. The INC considered that the amount of product released into the environment predominates over the specific concentration of the ingredient in the product. At the end of this first step, each ingredient had an initial score specific to the product category and each risk type.

All the scores, for each ingredient in a product, were aggregated according to their hazard level (from 1 to 5). The number obtained for each hazard level was then inserted into a formula simulating a chemical exposure risk assessment chart or chemical risk hierarchy inspired by those suggested by INRS for the assessment and prevention of chemical hazards (Vincent et al. 2005): relationship between the recurrence of the same hazard level from the ingredient list of the HDCP (corrected for health concentration), the use of the product, and a very simplified toxic equivalency factor for health or environment, respectively. The health and environmental results were in turn aggregated separately to obtain an overall score related to product use. To account for specific substances whose recurrence of exposure for the consumer was too important and/or too problematic for health and/or for the environment according to bibliographic toxicological references, but not considered by ECHA, a factorial penalization was attributed to the general score (*e.g.*, endocrine disruptors, Carcinogenic, mutagenic and reprotoxic chemicals, pollutants ...). For example, thiazolinones, which have irritant and sensitizing effects (INRS 2021), are used at minimal levels in products to ensure their preservation. However, many products contain them (paints, cosmetics, other household products), and contribute to a higher overall level of exposure than if each product were considered individually. Thus, the recurrence of exposure to certain molecules across all consumer products was accounted for. Two numerical notes (ranging from 0: highest risk to 20: lowest risk) were thus obtained, one for health and one for the environment. The two notes for health and environment were then added together, according to the weighting of 70% for the health score and 30% for the environment score, to obtain an overall note. A final Ménag'score® was obtained by dividing a corresponding note in 5 ranked intervals (0-4=E, >4-8=D, >8-12=C, >12-16=B and >16-20=A). For the present analysis, we created reversed numerical notes, with 0 representing the lowest risk and 20 the highest risk, which is more intuitive and consistent with the final Ménag'score® classification. Thus, 3 notes (0 to 20) and 3 categorical scores (A to E) where available per HDCP (Ménag'score®-health, Ménag'score®–environment and Ménag'score®-overall).

Then, for each score (Ménag'score®-health, Ménag'score®–environment and Ménag'score®-overall) three exposure variables were defined: (a) The highest score among all weekly used HDCP (reference: no HDCP use, HDCP use with a frequency lower than weekly, or weekly use of HDCP scored A, B or C; exposed: weekly use of at least one HDCP scored D or E) (b) The number of weekly used HDCP scored D or E (c) The maximum numerical note among all weekly used HDCP. Moreover, we also classified HDCP ingredients into two categories according to their hazard statements in notifications

appearing in the Classification and Labelling Inventory of the ECHA database: (a) as irritants for CLP codes H314 or H315 or H318 (b) as sensitizers for CLP codes H334 or H317 (European Parliament and Council 2021).

Covariates

Age at baseline (first trimester of pregnancy) was considered as a continuous variable. Smoking status was defined as a 2-class variable, with "current smokers" defined by at least 1 cigarette per day between conception and pregnancy detection. Body Mass Index (BMI) was calculated from height and weight before pregnancy and considered as a 2-class variable, with a threshold of 25kg.m^{-2}. These 3 factors were considered as potential confounders consistently with previous studies on associations between HDCP and asthma in adults (Le Moual et al. 2012; Bédard et al. 2014; Matulonga et al. 2016; Weinmann et al. 2017; Dumas et al. 2021).

Statistical analysis

Descriptive statistics were calculated for the main characteristics of the included participants. Associations between each Ménag'score® (overall, health and environment) of HDCP used weekly and the 2-level asthma symptom score were evaluated by a Generalized Estimating Equations models (PROC GENMOD; SAS), to account for repeated data, and adjusted for age, BMI and smoking status. All analyses were performed on a complete case basis. Analyses were performed using SAS version 9.3 (SAS Institute Inc., Cary, NC, USA).

Results

A total of 103 participants were included (figure 2). Out of the 381 participants excluded, 55 had missing asthma questionnaire data and 326 did not use the application at any data collection times (of which 324 were included before 2017). Participants excluded for having never used the BC-App are similar to a previous work and were not statistically different from the included participants (Lemire et al. 2021).

Main population characteristics are available in table 1. Out of the 103 included participants, 64% of the women had a normal BMI before pregnancy and 12% above 25. At inclusion 16% of the participants ever had asthma. At each data collection times, 60% to 70% of the participants weekly used at least one HDCP that was scored D or E, whatever the Ménag'score® considered (health, environment

and overall). The maximum numerical reversed health, environment and overall note for scanned products used weekly at T1 was (mean±s.d) 12.5±6.0, 12.9±6.0 and 13.1±6.9, respectively.

For 540 unique products, of which 443 were used weekly at least by one participant, the Ménag'score® was calculated. Participants using only at least one of the 97 other products (never used weekly) were classified as 'non-exposed'. The overall and health Ménag'scores® have a balanced distribution of scores from A to E (supplementary materials: table A1), while for the Ménag'score®–environment nearly 60% of the products had extreme scores A or E. The E category is represented twice as much for the Ménag'score®–environment than the Ménag'score®-health. The distribution of the Ménag'score® has been studied for some product categories, including products containing acetic acid (household vinegar; n=38) or bleach (n=44). Household white vinegar (n=25) had a Ménag'score®-health of B (n=22, 88%) or C (n=3, 12%) (depending on the form), and a Ménag'score®–environment of A. For 13 other products, acetic acid was included in their composition at variable relative concentrations, without clear relation with their Ménag'score®. The 44 products containing bleach had a Ménag'score®-health of C (n=14, 32%) or D (n=30, 68%) and a Ménag'score®–environment of B (n=9, 20%), D (n=15, 34%) or E (n=20, 46%).

The weekly use of at least one HDCP with a poor Ménag'score®-health (D or E) was significantly associated with a higher risk of asthma symptoms before (crude OR=3.15 95%CI [1.32-7.50]) and after adjustment (figure 3, adjusted Odd Ratios: ORa=3.11 [1.31-7.37]). We observed no statistically significant association with the Ménag'score®-overall (ORa=1.53 [0.66-3.53]), which corresponded to an intermediate risk level between the Ménag'score®-health (ORa=3.11 [1.31-7.37]) and the Ménag'score®-environment (ORa=1.00 [0.44-2.29]).

The number of HDCP used weekly classified D or E by the Ménag'score®-health was significantly associated with a higher risk of asthma symptoms (ORa per unit=1.25 [1.04-1.49]). No statistically significant association was observed with the Ménag'score®–environment (ORa per unit=1.07 [0.88-1.29]) nor with the Ménag'score®–overall (ORa per unit=1.15 [0.94-1.41]).

Weekly HDCP use, in number of products or total number of ingredients was associated with an increased risk of reporting at least one asthma symptom (Table 2). The use of irritant ingredients was associated with a higher risk of an asthma symptom score ≥1, but the association was no longer significant and slightly weaker after adjustment for potential confounders. No statistically significant association was observed with sensitizing ingredients. Considering the Ménag'score® note (0 to 20) as

continuous variables, the decrease of one unit of the Ménag'score® health and global were associated with a higher risk of asthma symptoms. No association was observed for the environment score.

Discussion

To the best of our knowledge, we are the first in the literature to investigate the respiratory health risk of HDCP based on an innovative risk-grading method integrating health and environment from the comprehensive list of HDCP ingredients. Weekly use of HDCP classified with a poor Ménag'score®-health or Ménag'score®-overall was significantly associated with a higher risk of presenting at least one asthma symptom, whereas no association was observed for Ménag'score®-environment. This analysis suggests that weekly use of HDCPs, according to the number of HDCP or notably irritant ingredients, is associated with a higher risk of asthma symptoms. The Ménag'score® may be an efficient public health tool to guide consumer choices towards less hazardous cleaning products.

The use of the Ménag'score® to assign a risk score to HDCP from their complete list of ingredients is original, thus, our results cannot be directly compared with those from the literature. In Sepages, we observed that around 90% of the women reported a weekly use of HDCP (Lemire et al. 2021) and 60% to 70% used at least one HDCP weekly (BC-App) with a Ménag'score® scored D or E. Moreover, using HDCP questionnaire assessment in Sepages (Lemire et al. 2021), we observed a similar reported frequency of use than in the European Community Respiratory Health Survey (ECRHS; Zock et al. 2007) for sprays (Sepages: 37% vs ECRHS: 42%) but a lower one for bleach (11% vs 28%) and scented products (41% vs 68%). Liquid multiuse cleaning products were the most frequent, 83% of ECRHS participants reported using this HDCP category at least weekly. Therefore, either considering the questionnaire or the BC-App, the Sepages population seems in line with previous reported HDCP weekly usage rate, and it should not affect risk estimates.

The Ménag'score® represents an interesting approach and may be used as a public health tool to inform in a simple way the consumers about health risks associated with HDCP use. The Ménag'score® weight in its calculation cumulative exposures to specific pollutants across household products, which may be substantial (Stanfield et al.). In addition to the Ménag'score®, the ingredients were categorized by scientists from INC as irritants or sensitizers according to the CLP hazard statements (EU-OSHA 2021). A significant association was observed between the number of irritant ingredients and a higher risk of asthma symptoms, but not for the number of sensitizing ingredients. These results are consistent with a

previous work in the French E3N cohort (Lemire et al. 2020) and reinforce the hypothesis on the deleterious respiratory health effects of chronic exposure to irritants (Dumas and Le Moual 2016). Perfumes used in HDCP may be respiratory sensitizers. However, regulation does not require manufacturers to state the precise names of perfumes and colourants that constitutes less than 0.01% of the HDCP in their ingredients lists. Therefore, the absence of association observed in our results between sensitizers ingredients and asthma symptoms may be due to an underestimation of the number of sensitizers in HDCP. Other methods have been suggested to categorize chemicals according to their irritant or sensitizing properties such as Quantitative Structure Activity Relationship (Lee et al. 2021). Investigating methods of categorization of ingredients into sensitizers and irritants may be relevant in the study of immunodependent (sensitizers) and non-immunodependent (irritants) mechanisms of asthma.The main strength of this study consists in the exposure assessment, based on an original method assessing *a priori* health risks for each product according to its ingredients collected using a friendly BC-App. Noteworthy, our study supports the Ménag'score® method by showing association between the asthma score and the Ménag'score®-health, while no association was observed with the environment score, which is consistent with our *a priori* hypothesis. Our results regarding the number of HDCP, and the number of ingredients especially irritant compounds, suggested a dose-response relationship and are consistent with available scientific evidence, and biologically plausibility of irritant properties (Archangelidi et al. 2020; Tarlo 2021). The Ménag'score®, composed of 70% of the health score and 30% of the environment score, is positioned as an intermediary between the health and environment scores. These results suggest a strong interest of the Ménag'score®-health as a public health tool. By construction, the Ménag'score® accounts in its calculation for the category of product used, both in terms of tasks (bathroom products) or format (spray, liquid). The integration of the relative concentration of the ingredients, the category of the HDCP and the knowledge in the literature on particularly at-risk substances (for health in the case of the health score) in unique score makes it a comprehensive and relevant tool in the study of the effects of HDCP on health.

This study has some limitations. The Sepages study has a limited number of participants with a low proportion of asthma symptom scores ≥1. These numbers prevented any sensitivity analyses, including stratification (on socioeconomic status and workplace exposure), or consideration of frequency of use (Zock et al. 2007; Matulonga et al. 2016; Weinmann et al. 2017; Lemire et al. 2020) other than weekly. However, over than half of the Sepages women have high diploma level, as 94% of them have an

undergraduate or graduate university degree (Lyon-Caen et al. 2019), and therefore the number of women exposed at work may be limited. Moreover, this limit the impact of socio-economic status as a confounder in our study as education level is homogenous and high in the Sepages population. In addition, pregnancy can have unexpected effects on asthma (Global Initiative for Asthma 2021), an effect on observed association is therefore hard to estimate. The specificity of the Sepages population limits the possible generalization of the results. The method to evaluate exposure, the BC-App used in the SEPAGES cohort has limits that were discussed in a previous work (Lemire et al. 2021). Briefly, the BC-App was used over a single week that may not reflect a typical week nor long term change in HDCP use habits. The quality of ingredients information collected through the BC-App relied on manufacturer's ingredients lists, although their commitment could not be assessed. Ingredients data quality is of importance, as it is the base of the Ménag'score® calculation. The exact calculation method of the Ménag'score® is confidential, which limits the interpretation of the current findings. Therefore, we cannot extensively discuss the underlying hypothesis for the calculation of the Ménag'score®. Moreover, the Ménag'score® is not specific to asthma: all health risks presented by the HDCP are considered. In addition, though the Ménag'score® is confidential, researchers interested in using it may ask for a partnership with the INC. Further studies are needed to investigate the relationships between the Ménag'score® and asthma or other health outcomes.

We have studied the Ménag'score®, which was intended as a public health communication tool (overall), and its two underlying components (health and environment) separately. Our analysis showed a significant association between the asthma symptoms and the health component of the Ménag'score®, but not its environment component. This observation questions the relevance of the environment component from a public health point of view, which represent a third of the Ménag'score®. However, the environment can be considered as a public health concern, as its degradation can lead to direct or indirect effect on human health, that our analysis is not able to account for. Thus, including environmental concern in the Ménag'score®-overall may be relevant. Indeed, when considering the Ménag'score®-overall as a numerical note (more powerful for statistical analyses), a higher note was significantly associated with a lower risk of asthma symptoms, as for the health component. Additional studies of consumer perception of the Ménag'score® composite aspect, as well as a reflection on its communication would be relevant for its use as a public health tool. The Ménag'score® may be of greater interest for the consumer than existing mandatory ingredients list at the back of the product (Lee et al. 2020) as it would

include a toxicological safety assessment based on available scientific evidence. The Ménag'score® is similar in presentation and objective to the Nutri-score, an already deployed front-of-pack label for food (Chantal et al. 2017; Dréano-Trécant et al. 2020). Moreover, French lawmakers has the objective to create a safety label for HDCP and anticipating the need for future research to support its public health relevancy may be key in its deployment. Thus, the Ménag'score® meet a public health demand, and appears feasible and realistic. In epidemiologic studies, the environmental and health components of the Ménag'score® may be more useful than the overall score, as they are unidimensional, and thus easier to interpret. The Ménag'score® grading method may also be relevant in occupational studies to assess the risk for health of cleaning products used at workplace. However, the Ménag'score® may need to be adapted to the specific ingredients and patterns of exposure of cleaning products use at work, especially in healthcare settings.

Conclusion

A weekly use of HDCP classified with a poor Ménag'score®-health was significantly associated with a higher risk for respiratory health. These results provide first evidence of the relevance of the Ménag'score® in environmental epidemiological research and call for additional larger studies investigating the health impact associated with this Ménag'score® built to be used as a front-of-pack label in a public health effort.

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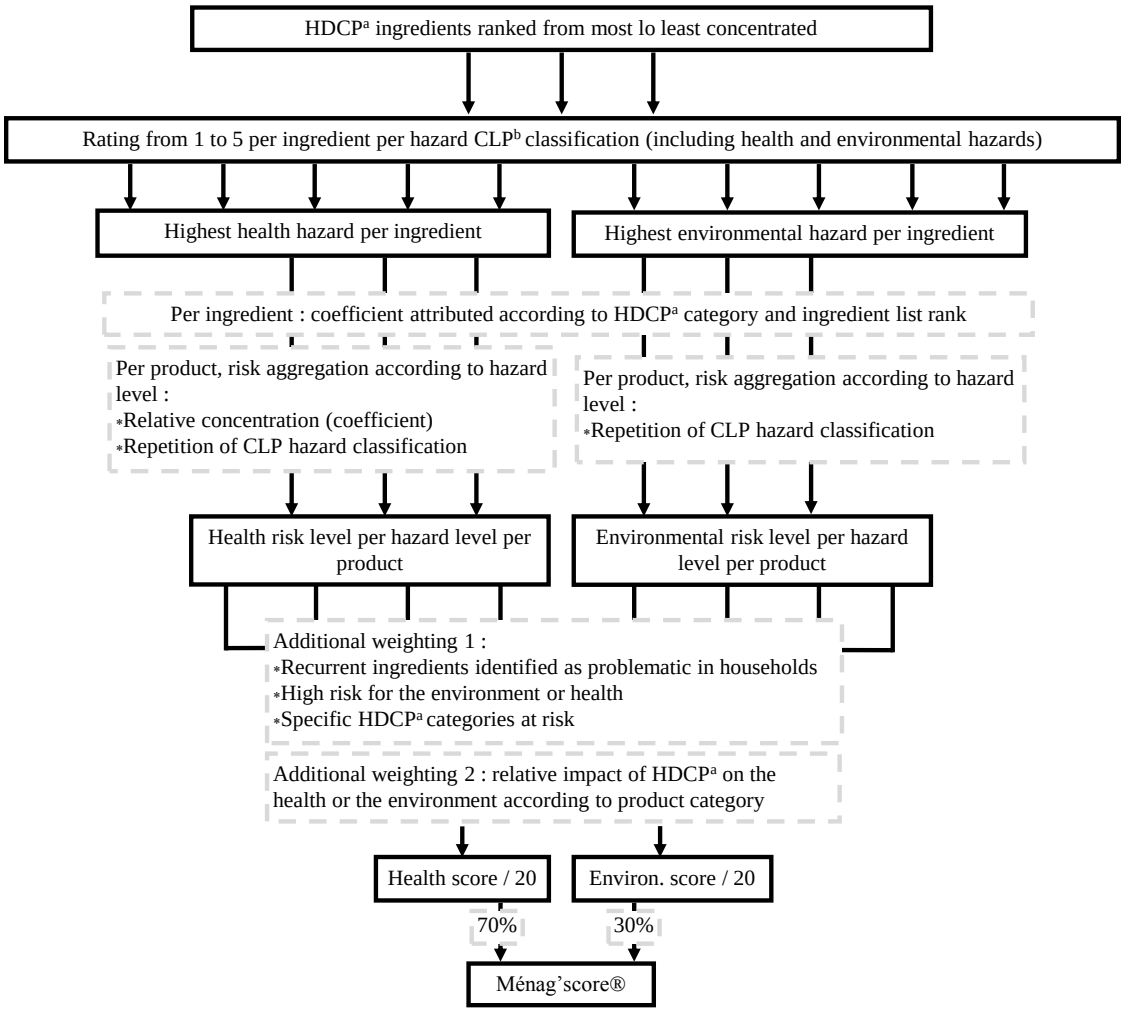
Figures and tables



[a] HDCP : Household Desinfectant or Cleaning product
[b] CLP : *Classification, Labelling, Packaging*

Fig1. Ménag'score® main steps of computation

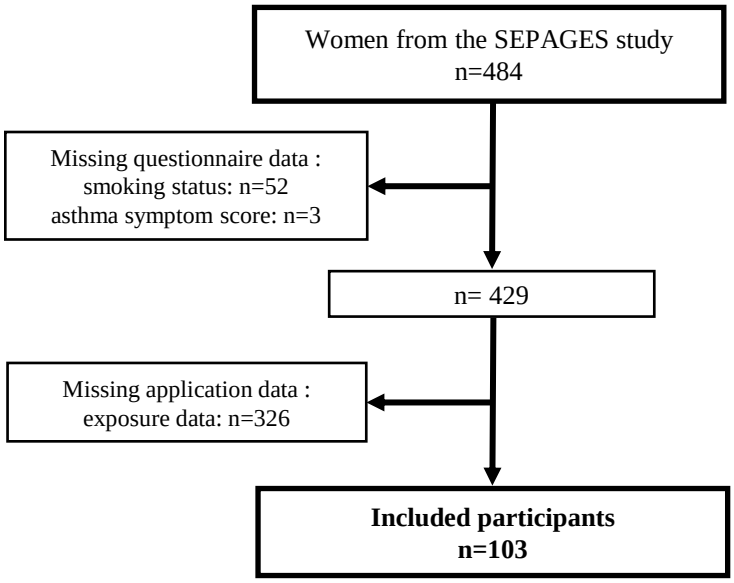


Fig2. Flowchart of the selected population

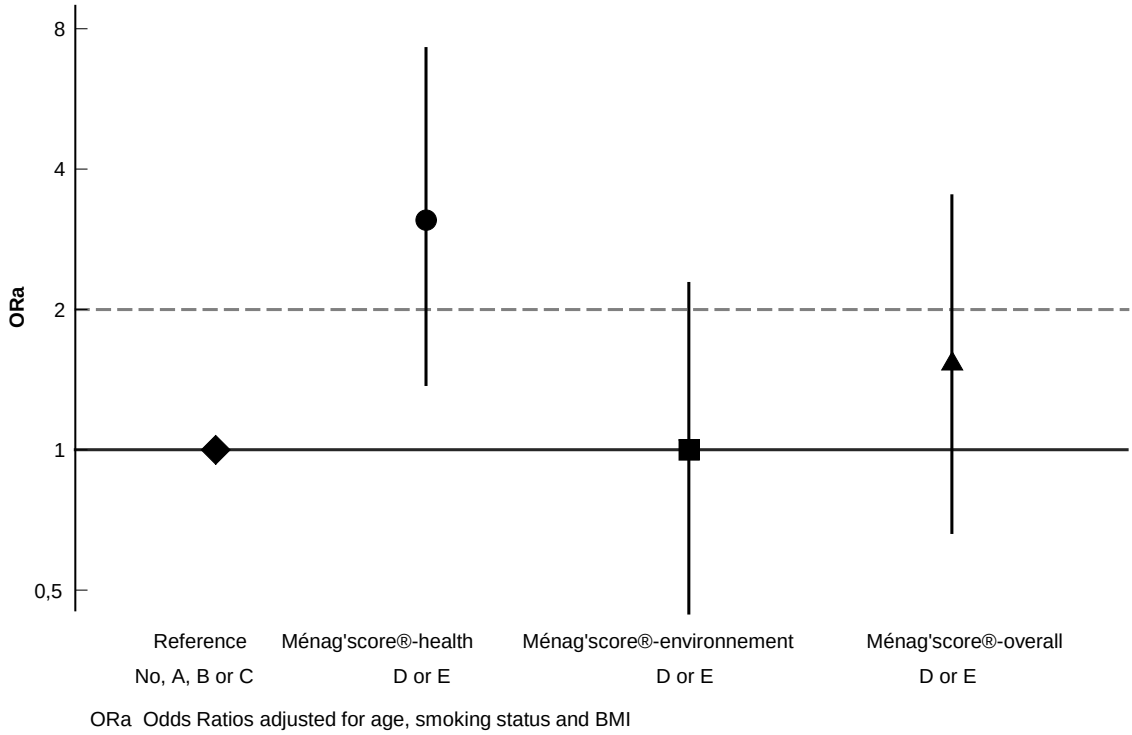


Fig3. Associations between Ménag'score® of weekly used HDCP and asthma symptom score ≥1, according to the maximum or weekly number of Ménag'score® of either D or E

Table 1 : Included women characteristics from the Sepages cohort according to data collection times

	T1 [a]	T3 [a]	Y1 [a]
Questionnaire data, n	**103**		
Age (years)[b], mean ± sd	32.5 ± 3.6		
BMI [a] (Body Mass Index - kg.m^{-2})	100		
Mean ± sd	22.4 ± 3.9		
>25	12 (12.0)		
Smoking status[c]	103		
Current smoker	11 (10.7)		
Asthma symptom score[d]	98	97	97
≥1	18 (18.4)	17 (17.5)	6 (6.2)
BC-App and ingredients data, n	**42**	**80**	**78**
Weekly HDCP			
Number of HDCP			
Median [Q1; Q3]	3 [2;5]	3 [2;6]	2 [1;4]
Number of Ingredients			
Sum: Median [Q1; Q3]	41 [14;63]	39 [14;65]	26 [11;59]
Ingredients categorized as irritants (CLP [e])			
Sum: Median [Q1; Q3]	12 [4;20]	12 [5;23]	10 [3;21]
Ingredients categorized as sensitizers (CLP [e])			
Sum: Median [Q1; Q3]	4 [0;10]	4 [1;9]	4 [0;8]
Ménag'score®-overall (maximum)			
No HDCP	3 (7.1)	6 (7.5)	7 (9.0)
A	1 (2.4)	1 (1.3)	1 (1.3)
B	8 (19.1)	7 (8.8)	13 (16.7)
C	6 (14.3)	12 (15.0)	8 (10.3)
D	11 (26.2)	23 (28.8)	23 (29.5)
E	13 (31.0)	31 (38.8)	26 (33.3)
Number of HDCP scored D or E, median [Q1; Q3]	1 [0;2]	1 [0;2]	1 [0;2]
Ménag'score®-health (maximum)			
No HDCP	3 (7.1)	6 (7.5)	7 (9.0)
A	1 (2.4)	0 (0.0)	0 (0.0)
B	4 (9.5)	5 (6.3)	12 (15.4)
C	8 (19.1)	16 (20.0)	14 (18.0)
D	12 (29.0)	20 (25.0)	21 (27.0)
E	14 (33.3)	33 (41.3)	24 (30.8)
Number of HDCP scored D or E, median [Q1; Q3]	1 [0;3]	1 [0;2]	1 [0;2]
Ménag'score®–environment (maximum)			
No HDCP	3 (7.1)	6 (7.5)	7 (9.0)
A	3 (7.1)	4 (5.0)	7 (9.0)
B	6 (14.3)	11 (13.8)	10 (12.8)
C	3 (7.1)	4 (5.0)	2 (2.6)
D	5 (11.9)	9 (11.3)	7 (9.0)
E	22 (52.4)	46 (57.5)	45 (57.7)
Number of HDCP scored D or E, median [Q1; Q3]	1 [0;2]	1 [0;3]	1 [0;2]

All data are in n (%), except as specified
[a]: time of data collection: first trimester of pregnancy (T1), third trimester of pregnancy (T3), second month after delivery (Y1);
[b]: before pregnancy, data not repeated;
[c]: between conception and detection of pregnancy;
[d]: data collected one year after delivery for the third time (Y1) and not two months (Y1);
*[e]: European Classification, Labeling, Packaging (CLP) regulation; *complete list checked against first publication*

Table 2: Associations between weekly use HDCP and asthma symptom score, according to the number of HDCP, of their ingredients or their Ménag'score®

	Asthma score ≥1[a]	
Weekly HDCP	Crude OR [95%CI] (n=191)	Adjusted OR[b] [95%CI] (n=187)
Number of HDCP, n		
Continuous (unit=one)	**1.19 [1.03-1.36]**	**1.16 [1.01-1.34]**
Number of ingredients[c], n		
Continuous, (unit=one IQR=48)	**1.63 [1.03-2.57]**	1.53 [0.98-2.40]
Sum of ingredients categorized as irritants (CLP[d])		
Continuous, (unit=one IQR=17)	**1.51 [1.00-2.27]**	1.38 [0.93-2.04]
Sum of ingredients categorized as sensitizers (CLP[d])		
Continuous, (unit=one IQR=9)	1.33 [0.76-2.33]	1.14 [0.66-1.95]
Ménag'score® note 0 (no risk) -20 (high risk)[e]		
Health	**1.10 [1.04-1.17]**	**1.10 [1.03-1.16]**
Environment	1.03 [0.98-1.08]	1.02 [0.97-1.07]
Overall	**1.06 [1.00-1.13]**	**1.06 [1.00-1.12]**

[a] *Source of data used for analyses; all collected data are used for each participant (Repeated data analyses: Generalized estimating equation models);*
[b] *Adjusted for age, Body Mass Index (BMI; pre-pregnancy), and smoking status (between conception and pregnancy detection);*
[c] *Sum of the ingredients of all HDCPs used at least once per week per participant;*
[d] *European Classification, Labeling, Packaging (CLP; European Chemicals Agency) regulation;*
[e] *using the reversed note: Weekly maximum continuous note ranging from 0 to 20, 0 meaning the lowest risk according to the Ménag'score®*