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Lifestyle factors and multimorbidity: a cross sectional study

Martin Fortin[1,2*], Jeannie Haggerty[3], José Almirall[1,2], Tarek Bouhali[1,2], Maxime Sasseville[2] and Martin Lemieux[1,2]

Abstract

Background: Lifestyle factors have been associated mostly with individual chronic diseases. We investigated the relationship between lifestyle factors (individual and combined) and the co-occurrence of multiple chronic diseases.

Methods: Cross-sectional analysis of results from the Program of Research on the Evolution of a Cohort Investigating Health System Effects (PRECISE) in Quebec, Canada. Subjects aged 45 years and older. A randomly-selected cohort in the general population recruited by telephone. Multimorbidity (3 or more chronic diseases) was measured by a simple count of self-reported chronic diseases from a list of 14. Five lifestyle factors (LFs) were evaluated: 1) smoking habit, 2) alcohol consumption, 3) fruit and vegetable consumption, 4) physical activity, and 5) body mass index (BMI). Each LF was given a score of 1 (unhealthy) if recommended behavioural targets were not achieved and 0 otherwise. The combined effect of unhealthy LFs (ULFs) was evaluated using the total sum of scores.

Results: A total of 1,196 subjects were analyzed. Mean number of ULFs was 2.6 ± 1.1 SD. When ULFs were considered separately, there was an increased likelihood of multimorbidity with low or high BMI [Odd ratio (95% Confidence Interval): men, 1.96 (1.11-3.46); women, 2.57 (1.65-4.00)], and present or past smoker [men, 3.16 (1.74-5.73)]. When combined, in men, 4-5 ULFs increased the likelihood of multimorbidity [5.23 (1.70-16.1)]; in women, starting from a threshold of 2 ULFs [1.95 (1.05-3.62)], accumulating more ULFs progressively increased the likelihood of multimorbidity.

Conclusions: The present study provides support to the association of lifestyle factors and multimorbidity.

Keywords: Multimorbidity, Lifestyle factors, Smoking habit, Alcohol consumption, Fruit and vegetable consumption, Physical activity, Body mass index

Background

Public health programs designed to fight chronic diseases should always consider lifestyle factors as important targets for prevention. The importance of lifestyle factors in health and disease has been the subject of many studies, and much of the information has been collected and analyzed in reports that unequivocally show a close relationship between lifestyle factors and many chronic diseases [1-4].

Because of its association with chronic diseases, each individual lifestyle factor becomes an important element to take into account in the prevention of these diseases. Furthermore, the combination of preventive lifestyle factors

has also been reported to prevent the occurrence of chronic medical conditions [5-7]. Although the attributable risk of disease differs for individual lifestyle factors, epidemiologic evidence demonstrates that significant morbidity and mortality benefits are accumulated over any and all healthy lifestyle factors [7-11].

The link between lifestyle factors and chronic diseases has been studied mostly by analyzing individual lifestyle risk factors or their combinations associated with individual chronic diseases [11-18]. The association of lifestyle risk factors with the co-occurrence of multiple long-term or chronic diseases in one individual (multimorbidity) has been explored for physical activity in elderly patients [19], obesity [20-24], smoking [24], alcohol consumption [24], and nutrition [24,25]. However, the association of accumulating risk factors in the same individual and multimorbidity has not been explored. The aim of the present study was to analyze the association

* Correspondence: Martin.Fortin@USherbrooke.ca
[1]Département de médecine de famille et de médecine d'urgence, Université de Sherbrooke, Québec, Canada
[2]Centre de santé et de services sociaux de Chicoutimi, 305 St-Vallier, Chicoutimi, Québec G7H 5H6, Canada
Full list of author information is available at the end of the article

between individual lifestyle factors and their combinations with the occurrence of multimorbidity as well as the effect of their accumulation in an individual. We wanted to test the hypothesis that the accumulation of unhealthy lifestyle factors is associated with increased likelihood of multimorbidity

Methods

Study design and setting

The present study is a cross-sectional analysis conducted among a cohort of the general population recruited for a larger project (the Program of Research on the Evolution of a Cohort Investigating Health System Effects, PRE-CISE) [26] within the geographic boundaries of four local healthcare networks in Quebec, Canada. These networks are located in metropolitan, urban, rural and remote settings.

Participants

A randomly-selected cohort was recruited from March to April 2010 through a telephone survey. The survey firm hired for this task generated a random list of telephone numbers mapped to the postal code areas that correspond to the administrative boundaries of the four networks identified. Once contact was made, staff selected the adult in the household with the most recent birthday to ensure random selection. Participants had to be aged between 25 and 75 years, able to respond to written and oral questions in English or French and reside in one of the four networks identified. The purpose was to include 2000 subjects in the study. For this reason, an initial over-recruit by 20% (2,400) was made.

Data collection

At recruitment, participants reported on socio-demographic information (age, gender, family income, education, etc.). Two weeks after recruitment, participants completed a self-administered questionnaire (paper, internet or telephone response) that included the instruments to measure illness burden and lifestyle factors.

To capture the multi-dimensional nature of socio-economic status, we produced a data-driven classification of socio-economic status based on several variables that were considered important. The variables used were: education level, perceived financial situation, house ownership, presence or absence of medical insurance, and the possession of a retirement plan. Using a split sample, principal component analysis (PCA) was performed to summarize the different variables into smaller groups of "factors" (weighted sum of variable values). These factors then served as a basis for the classification of participants into four relatively homogenous socio-economic clusters. Definitional criteria for the four socio-economic clusters were:

1) Elite Group: College or university education AND perceived financial situation as "comfortable" or "very comfortable".
2) Middle-high: College or university education OR perceived financial situation as "comfortable" or "very comfortable".
3) Middle-low: High school education and perceived financial situation as "modestly comfortable" OR less than high school education and perceived financial situation less than "tight" but possess a retirement plan and complimentary medical insurance.
4) Low: Less than high school education and perceived financial situation less than "tight" but does not possess a retirement plan or complimentary medical insurance.

The outcome of interest, multimorbidity, was defined as the presence of three or more chronic conditions, measured by a simple count of the number of chronic conditions present in the subjects from a list of 14 conditions (hypertension, cholesterol elevated, asthma, chronic obstructive pulmonary disease, diabetes, thyroid disorder, osteoarthritis, rheumatoid arthritis, osteoporosis, colon problem, angina/coronary artery disease, stroke, congestive heart failure, and cancer) of the Disease Burden Morbidity Assessment by self-report [27,28]. The presence and intensity of lifestyle factors were evaluated using lifestyle-specific subscales from the Behavioural Risk Factor Surveillance System Questionnaire [29].

Lifestyle factors considered were: 1) smoking habit, 2) alcohol consumption, 3) fruit and vegetable consumption, 4) physical activity, and 5) body mass index (BMI). Each lifestyle factor was given a score of 1 (unhealthy) if recommended behavioural targets were not achieved and 0 otherwise. The criteria for classifying participants as not achieving recommended behavioural targets were the following: 1) present or past smoker; 2) high risk alcohol consumption (more than 10 standard drinks per week for women; more than 15 standard drinks per week for men) [30]; 3) insufficient fruit and vegetable consumption (less than five portions daily; 1 portion = 4 ounces or 125 ml); 4) not physically active (less than 20-30 min. of exercise 4 times per week); 5) low or high BMI (normal BMI: 18.5-24.9 Kg/m^2) [31]. The combined effect of unhealthy lifestyle factors was evaluated using the total sum of lifestyle specific scores in each subject [7,13,32], yielding an overall score for combined unhealthy lifestyle factors ranging from 0 to 5.

Data analysis

For this study, only patients of age 45 and over were considered in the analysis. The specific prevalence of multimorbidity was estimated by the number of unhealthy lifestyle factors and sex. Calculations of relative

risks and 95% confidence intervals (95% CI) were used to evaluate differences in the prevalence of multimorbidity in the groups with different numbers of lifestyle factors, using the prevalence of multimorbidity in the group with lower unhealthy lifestyle factors as the reference category.

We used logistic regression modeling to calculate the odd ratios for the likelihood of multimorbidity by lifestyle factor, adjusting for age, education, and socioeconomic class. All these covariates have been reported to be associated with multimorbidity.

Ethical aspects

Major ethical concerns were ensuring confidentiality and maintaining participation throughout the study period. Only the project coordinator and principal investigator had access to the link between nominal information and the unique study identification code. Subjects signed an informed consent to participate in the study, and the individual's right to withdraw partially or completely was reiterated at data collection efforts. The study was approved by the scientific and ethics committees of the Centre de santé et de services sociaux de Chicoutimi, as well as the Research Ethics Committee of Hôpital Charles Lemoyne, Quebec.

Results

A total of 2,458 subjects were recruited. Among them, 2,409 subjects were eligible. A total of 1,718 subjects (70% of those initially recruited) returned the completed questionnaires. We included in the study 1,196 subjects of age 45 or older found in the sample. Characteristics of participants are shown in Table 1. The percentage of subjects not achieving recommended behavioural targets for the five lifestyle factors by sex are shown in Table 2. With the exception of physical activity, the percentage of subjects not achieving recommended behavioural targets for each lifestyle factor was statistically significant different between men and women. Due to the difference in distribution of adherence to lifestyle factors by gender, all the analyses were conducted separately for men and women.

The odd ratios of the bivariate effect of each lifestyle factor for the presence of multimorbidity are shown in Figure 1. Physical activity and alcohol consumption showed no association with the presence of multimorbidity for either men or women. The odd ratios of the additional independent effect of each lifestyle factor over and above the others on the presence of multimorbidity, adjusted for age, education and socioeconomic class, are shown in Table 3. A lower or higher than normal BMI was the only lifestyle factor associated with higher likelihood of multimorbidity in both sexes. Being a current or past smoker was also associated with a higher likelihood

of multimorbidity in men but not in women. No association with the presence of multimorbidity was found with not eating a recommended amount of fruit and vegetables, physical activity or alcohol consumption for either men or women.

The overall mean number ± SD of unhealthy lifestyle factors in the cohort was 2.6 ± 1.10. The percentage of subjects with 0, 1, 2, 3, 4, and 5 unhealthy lifestyle
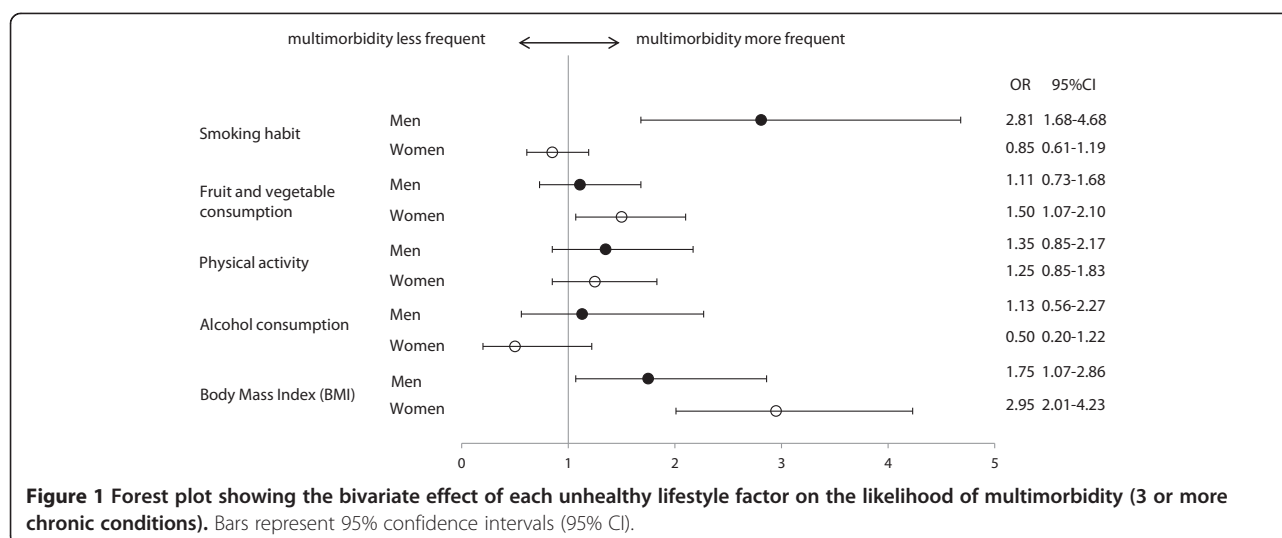
Table 1 Characteristics of participants

	Men (n = 515)	Women (n = 681)	p
Age: mean (SD)	58.0 (7.9)	57.6 (8.2)	0.300
Patients by number of diseases: n (%)			0.508
0 disease	153 (29.7)	175 (25.7)	
1 disease	121 (23.5)	148 (21.7)	
2 diseases	102 (19.8)	154 (22.6)	
3 diseases	81 (15.7)	114 (16.7)	
4 diseases	31 (6.0)	48 (7.0)	
5 or more diseases	27 (5.2)	42 (6.2)	
Socio-economic classes: n (%)			0.399
Elite group	109 (21.2)	123 (18.1)	
Middle-high	206 (40.0)	296 (43.5)	
Middle-low	110 (21.4)	133 (19.5)	
Low	70 (13.6)	99 (14.5)	
Missing data	20 (3.9)	30 (4.4)	
Education: n (%)			0.220
Incomplete secondary school or lower	144 (28.0)	166 (24.4)	
Completed secondary school	162 (31.5)	209 (30.7)	
College	79 (15.3)	133 (19.5)	
University	129 (25.0)	170 (25.0)	
Missing data	1 (0.2)	3 (0.4)	

Table 2 Percentage of subjects not achieving recommended behavioural targets for each lifestyle factor

Lifestyle factor	Men	Women	p
Smoking habit: Present or past smoker	70.7	58.9	0.000
Fruit and vegetable consumption: Less than five portions* daily	62.3	37.6	0.000
Physical activity: Less than 20–30 min. 4 times/week	72.8	71.2	0.641
Alcohol consumption: High-risk drinking**	8.2	5.0	0.045
Body Mass Index (BMI): Low or high BMI***	71.3	57.3	0.000

* One portion = 4 ounces or 125 ml.
** High-risk drinking: More than 10 standard drinks per week for women; More than 15 standard drinks per week for men (1 standard drink = 1 small beer or 1 glass of wine or 1 glass of spirits/liquor).
*** Normal BMI: 18.5 – 24.9 Kg/m^2.

Figure 1 Forest plot showing the bivariate effect of each unhealthy lifestyle factor on the likelihood of multimorbidity (3 or more chronic conditions). Bars represent 95% confidence intervals (95% CI).

factors by sex are shown in Table 4. This analysis was limited to those subjects whose total lifestyle score could be calculated. Subjects with one or more missing values were not included in the analysis. Because the number of subjects who had 0 or 5 unhealthy lifestyle factors was small, these categories were combined as a single group with the categories of 1 and 4 unhealthy lifestyle

factors, respectively. Therefore, we analyzed the categories of 0-1, 2, 3, and 4-5 unhealthy lifestyle factors. Results of the logistic regression analysis for the likelihood of multimorbidity associated with the number of unhealthy lifestyles factors adjusted for age, education and socioeconomic class are shown in Table 5. The presence of 2 unhealthy lifestyle factors, or more, significantly

Table 3 Odds ratios and 95% confidence intervals (95% CI) of the additional independent effect of each lifestyle factor over and above the others on the likelihood of multimorbidity (3 or more chronic conditions), adjusted for age, socioeconomic class, and education (p = 0.005 for interaction with sex in a model with men and women together)

	Men			Women		
Lifestyle factors	p	Odds ratio	95% CI	p	Odds ratio	95% CI
Smoking habit: Present or past smoker	0.000	3.16	1.74-5.73	0.907	0.98	0.64-1.49
Fruit and vegetable consumption: Less than five portions* daily	0.838	0.95	0.59-1.54	0.089	1.46	0.94-2.26
Physical activity: Less than 20–30 min. 4 times/week	0.257	1.38	0.79-2.42	0.290	1.29	0.81-2.06
Alcohol consumption: High-risk drinking**	0.872	0.94	0.43-2.03	0.709	0.83	0.31-2.23
Body Mass Index (BMI): Low or high BMI***	0.020	1.96	1.11-3.46	0.000	2.57	1.65-4.00
Covariates						
Age	0.000	1.07	1.04-1.11	0.000	1.11	1.08-1.15
Socioeconomic class						
Elite group	-			-		
Middle-high	0.751	0.90	0.46-1.76	0.331	1.35	0.74-2.46
Middle-low	0.900	0.94	0.38-2.37	0.257	1.64	0.70-3.87
Low	0.508	1.40	0.52-3.80	0.064	2.49	0.95-6.54
Education						
Incomplete secondary school or lower	-			-		
Completed secondary school	0.643	1.16	0.62-2.16	0.406	1.31	0.69-2.45
College	0.832	1.10	0.44-2.75	0.821	1.11	0.45-2.74
University	0.210	0.58	0.25-1.36	0.647	0.82	0.35-1.93

* One portion = 4 ounces or 125 ml.
** High-risk drinking: More than 10 standard drinks per week for women; More than 15 standard drinks per week for men (1 standard drink = 1 small beer or 1 glass of wine or 1 glass of spirits/liquor).
*** Normal BMI: 18.5 – 24.9 Kg/m^2.

Table 4 Subjects with 0, 1, 2, 3, 4, and 5 unhealthy lifestyle factors (men, n = 471; women, n = 580)

Number of unhealthy lifestyle factors	Men n (%)	Women n (%)
0	10 (2.1)	33 (5.7)
1	38 (8.1)	93 (16.0)
2	93 (19.7)	182 (31.4)
3	185 (39.3)	189 (32.6)
4	135 (28.7)	79 (13.6)
5	10 (2.1)	4 (0.7)

increased the likelihood of multimorbidity in women; accumulating unhealthy lifestyle factors progressively increased the likelihood of multimorbidity. In men, only the presence of 4-5 unhealthy lifestyle factors significantly increased the likelihood of multimorbidity.

Prevalence of multimorbidity by sex and number of unhealthy lifestyle factors as well as relative risks are shown in Figures 2 and 3. Relative risks above one in the 95% confidence intervals were observed with 2, 3, and 4-5 unhealthy lifestyle factors in women. Relative risks above one in the 95% confidence intervals were observed only with 4-5 unhealthy lifestyle factors in men.

Discussion

There is an important body of research showing that common lifestyle factors, either individually or combined, are associated with individual chronic conditions [1-7,11,14,18]. The present study suggests that some individual lifestyle factors as well as the combined effect of lifestyle factors are associated with the likelihood of the simultaneous presence of three or more chronic conditions in the same subject (multimorbidity). Considering lifestyle factors individually, the BMI and the smoking habit were lifestyle factors associated with a likelihood of multimorbidity. When lifestyle factors were combined, starting from a threshold of 2 lifestyle factors in women and 4–5 in men, accumulating unhealthy lifestyle factors progressively increased the likelihood of multimorbidity.

The lack of association with physical activity found in this study is at variance with a recent study reporting an inverse association between physical activity and multimorbidity among men aged 65–94 years [19]. Probably, the difference in age of subjects included in each study and different definitions of multimorbidity (2 or more vs. 3 or more chronic conditions) are at the origin of the discrepant results.

A recent publication reported that greater consumption of fruits and vegetable and whole grain products appear to lower the risk of multimorbidity [25]. These results are at variance with the finding in the present study that not eating a recommended amount of fruit and vegetables was not associated with a higher likelihood of multimorbidity. However, our results are in line with a study of Nadel and colleagues [24] in which adjustment for fruit and vegetable intake, physical activity,

Table 5 Odds ratios for the likelihood of multimorbidity (3 or more chronic conditions) by number of unhealthy lifestyle factors (ULF), adjusted for age, socioeconomic class, and education (p = 0.003 for interaction with sex in a model with men and women together)

| Number of ULFs	Men			Women		
	p	Odds ratio	95% CI*	p	Odds ratio	95% CI
0-1	-	1		-	1	
2	0.178	2.24	0.69-7.21	0.036	1.95	1.05-3.62
3	0.058	2.93	0.96-8.94	0.003	2.53	1.36-4.71
4-5	0.004	5.23	1.70-16.1	0.001	3.39	1.65-6.95
Covariates						
Age	0.000	1.07	1.04-1.10	0.000	1.12	1.09-1.15
Socioeconomic class						
Elite group	-			-		
Middle-high	0.750	0.90	0.47-1.73	0.269	1.40	0.77-2.55
Middle-low	0.922	0.96	0.39-2.36	0.173	1.81	0.77-4.24
Low	0.565	1.34	0.50-3.58	0.041	2.74	1.04-7.20
Education						
Incomplete secondary school or lower	-			-		
Completed secondary school	0.691	1.13	0.61-2.10	0.410	1.31	0.69-2.49
College	0.860	1.08	0.44-2.67	0.740	1.16	0.48-2.85
University	0.279	0.63	0.28-1.45	0.642	0.81	0.35-1.91

*CI = Confidence interval.
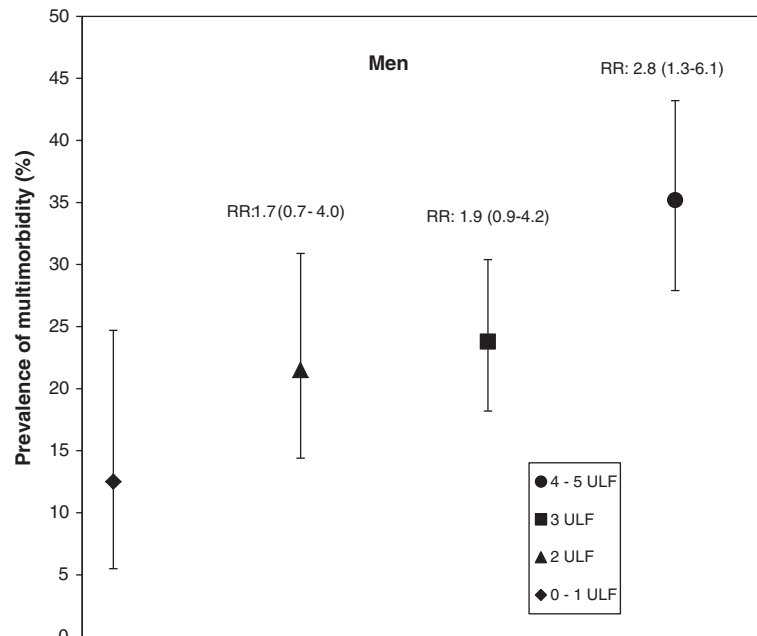
Figure 2 Prevalence of multimorbidity and number of unhealthy lifestyle factors (ULF) in men. Bars represent 95% confidence intervals (95% CI). Relative risks (RR) and 95% CI for each group, compared with the 0–1 LF group, are also shown.

and alcohol consumption did not substantially influenced the associations between multimorbidity and education in both men and women. However, the results of Nadel and colleagues are at variance with our finding of an association of smoking habit and multimorbidity in men.

The BMI has been repeatedly reported to be associated with multimorbidity [20-24]. Our study has confirmed this association. Indeed, the BMI was the only lifestyle factor associated with a likelihood of multimorbidity in both sexes.

In the present study, accumulation of unhealthy lifestyle habits was associated with a higher likelihood of
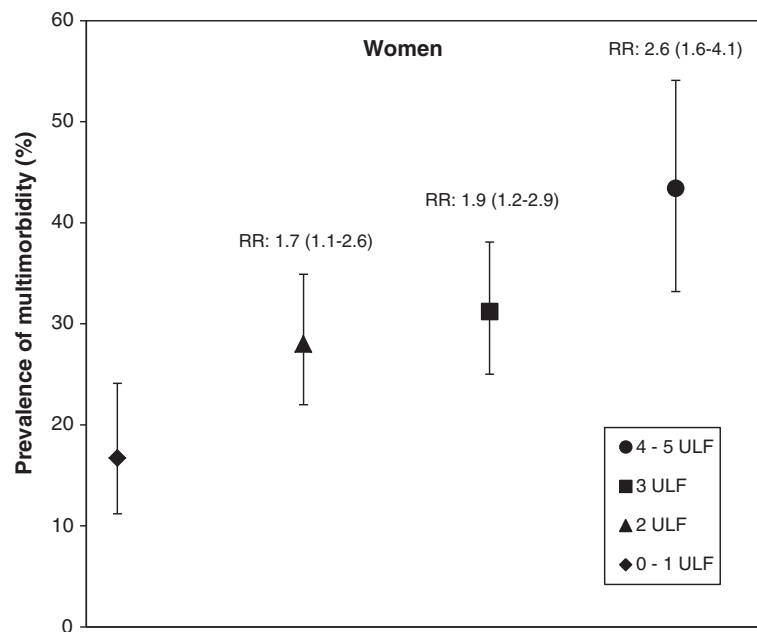
Figure 3 Prevalence of multimorbidity and number of unhealthy lifestyle factors (ULF) in women. Bars represent 95% confidence intervals (95% CI). Relative risks (RR) and 95% CI for each group, compared with the 0–1 LF group, are also shown.

multimorbidity. These findings concur with previous reports about a significant association of morbidity and mortality benefits with the accumulation of healthy lifestyle habits [7-11].

The results of this study supporting the link between lifestyle factors and multimorbidity point to the hypothesis that preventive measures could be considered an intervention in the fight against multimorbidity. However, it should be emphasized that although the identification of risk factors is an important aspect in the search for prevention and intervention strategies to address the increasing problem of multimorbidity, so is the person-centered approach. The high prevalence of multimorbidity implies the need for a holistic approach beyond the management of individual diseases. A person-centered approach promoting healthy lifestyles would maximize the number of healthy lifestyles in each individual, starting with whichever behaviour the person is most ready to adopt. The health care provider can use or refer the patient to strength-building approaches, such as motivational interviewing, that support patients in their decision to adopt a healthy behaviour and then to build or maintain the motivation to meet their goals. Building on the self-efficacy achieved for one behaviour, other behaviours can then be targeted [33,34].

There are several limitations in our study. The cross-sectional design of the study does not allow us to make a causal inference, thus, results need to be interpreted with that in mind. The self-report of lifestyle data may result in some misclassification. Nevertheless, this type of misclassification would likely be random. Also, the lifestyle factors were dichotomized, and we lost information on any dose–response because there are graded associations between some of the lifestyle factors and the occurrence of chronic conditions. The crude dichotomous categorization of lifestyle factors might underestimate the true effect of the various risk factors. However, previous studies have demonstrated that dichotomized lifestyle factors have been useful for studying the association of lifestyle factors and the risk of cancer [7], the prevention of chronic diseases [13], and all-cause mortality [32] in large populations. Overall lifestyle scores similar to the one we developed for the present study were used in these previous studies [7,32]. Regarding the measurement of multimorbidity, we considered 14 frequent chronic conditions, and this has an influence on prevalence estimates of multimorbidity. We have previously reported that a longer list of conditions would result in higher prevalence estimates [35]. Also, we had to rely on the self-reported presence of chronic conditions to measure multimorbidity and, hence, either over-reporting or under-reporting may have occurred. Finally, the results of this study are generalizable to the Canadian population where the study was conducted. Additional studies will be needed to evaluate the association of lifestyle behaviours and multimorbidity in other locations or populations.

Conclusions

This study provides support for the association of unhealthy lifestyle factors and multimorbidity. The increase in the likelihood of multimorbidity with the combined effect of unhealthy lifestyle factors may be used to hypothesise that the promotion of health positive lifestyle factors could be an intervention in the fight against multimorbidity.

Author details
[1]Département de médecine de famille et de médecine d'urgence, Université de Sherbrooke, Québec, Canada. [2]Centre de santé et de services sociaux de Chicoutimi, 305 St-Vallier, Chicoutimi, Québec G7H 5H6, Canada. [3]Faculty of medicine, McGill University, Montreal, Canada.

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