The intersectional impact of sex and social factors on subjective health: analysis of the Canadian Longitudinal Study on Aging (CLSA)

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Research Article

Keywords: sex differences, self-rated health, CLSA, intersectionality, social determinants

DOI: https://doi.org/10.21203/rs.3.rs-460405/v1

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Abstract

BACKGROUND Self-rated health (SRH) is a widely validated measure of the general health of older adults. Our aim was to understand what factors shape individual perceptions of health and how those perceptions vary for men and women and across social locations.

METHODS We used data from the Canadian Longitudinal Study on Aging (CLSA) of community-dwelling adults aged 45 to 85. SRH was measured via subjective questions. Multiple Poisson regression identified individual, behavioural, and social factors related to SRH. Intersections between sex, education, wealth, and rural/urban status, and individual and joint cluster effects on SRH were quantified using multilevel models.

RESULTS After adjustment for relevant confounders, women were 43% less likely to report poor SRH. The strongest cluster effect was for groupings by wealth (21%). When wealth clusters were subdivided by sex or education the overall effect on SRH reduced to 15 percent. The largest variation in SRH (13.6%) was observed for intersections of sex, wealth, and rural/urban status. In contrast, interactions between sex and social factors were not significant, demonstrating that the complex interplay of sex and social location was only revealed when intersectional methods were employed.

CONCLUSIONS Sex and social factors affected older adults' perceptions of health in complex ways that only became apparent when multilevel analyses were carried out. Utilizing intersectionality analysis is a novel and nuanced approach for disentangling explanations for subjective health outcomes.

1. Background

1.1. Conceptualization of self-rated health

The overarching question we examine in this study is what individual and contextual factors shape the subjective rating of health among older adults. Self-rated health (SRH) is a widely used predictor of mortality and physical functioning in general (1) and, particularly, among older populations (2). The usual measure is a single question asking for a rating of one's health using a five-point scale ranging from poor to excellent. This is often dichotomized into 'good' and 'poor'. The simplicity of this measure, its demonstrated validity (3), and its significant linear association with objective health indicators such as physical functioning (4) explain SRH's wide acceptance (5). Some authors argue, however, that the subjective aspect of SRH is increasingly problematic when older populations are studied (6). With aging, individual expectations and standards of good health evolve. Both perceptions of normal health status for a particular age and awareness of diagnoses that lack symptoms but raise the spectre of illness (eg hypertension) play important roles as reference points for an individual's self-rating. Older adults also may rate their health relative to their age cohort and related expectation rather than to some absolute standard (7). This shift in comparative baseline may be a way of coping with and adapting to declining health, but also makes tracking of SRH across the life-course and its reliability as an indicator of older
adults' objective health challenging. Still others have contested these presumed, age-related measurement modifications (7).

In addition to shifts arising from individual psychology, and expectations and perceptions of health over the life-course, older adults' SRH may also be shaped by norms and values aligned with group affiliation, whether those groups are social, cultural, or based on innate traits like sex. For example, when they rate their health the components considered by older men and women seem to be different (8). Men tend to focus specifically on physical well-being in making their determination whereas women take a broader view, considering mental health and levels of physical activity and function as contributing factors (8). According to a comprehensive framework proposed by Jylhä (6), what constitutes ‘health’ can also vary with geography and culture. At a contextual level, cultural norms and social roles affect self-assessments of health. For example, after controlling for related sociodemographic and health characteristics, Italians, Dutch men, and non-Hispanic whites assessed their health more positively than Finns, Lithuanian men, and Hispanics, respectively (6), while Germans underrated their health when compared to Danes or Swedes (9). Other authors suggest that Americans are 'health optimistic', finding that when compared to their Japanese counterparts and despite presenting poorer measured health outcomes, Americans rated their health more highly (10).

1.2. Sex and SRH across cultures and social circumstances

Among older adults, women generally report lower SRH than do men, however this finding varies across countries. It is supported by research from Brazil (11), USA (12), India (13), Canada (14), Spain, the Netherlands, Sweden, and Israel (15). In contrast, studies from Japan (16), Finland and UK (15) report poorer SRH for men than women. Even within countries findings are inconsistent; no sex/gender differences were found in some sample populations from Canada and Colombia (17, 18). It may be that culturally-based gender norms influence how women and men weigh components of SRH. Although this has not been studied, in theory, men in more traditional environments might consider physical robustness as central to better SRH while dismissing mental health as a contributing factor. Among older Europeans (19) and Africans (20) over age 15, there is some evidence that men and women interpret health factors similarly when rating their health. In contrast, among Koreans, hypertension was a stronger determinant of SRH in women than in men (21). Sex differences in SRH across cultures or other social locations might be embedded in group-specific differences in how women and men define health. In Latin America, where older women have lived in traditional societies with fewer social opportunities across the life-course they tend to report worse subjective health and physical functioning than do men (22). In contrast, in Canada, it may be that more expansive and egalitarian gender roles and older women's educational and socio-economic attainment that often meets that of age-matched men, shift women's perceptions of SRH (23). We hypothesize that conventions, definitions, and references used to assess health will vary across sex but also with intersections of sex and other social locations. This represents a gender effect rather than only an effect of sex.
Characteristics that fit within a social determinants of health framework such as education (12), income (11), race (24), rural/urban place of residence (25), marital status (26), and life-course adversities (27) all underpin perceptions of health among older adults (28).

The relative effect of inequalities in social circumstances on subjective health tends to decline with age, while the impact of contextual factors such as culture and geography becomes more prominent, a phenomenon referred to as ‘age-as-leveler’ (29). As a result, subjective health status differences may narrow among older people occupying similar social locations (30).

1.3. Intersectionality: sex, social factors, a measure of ‘gender’

To some extent, studies that perform sex-stratified analyses are able to disentangle effects of sex and social factors. For example, SRH effects of either income (31) or rurality (32) are sometimes stronger in women, whereas the effect of marital status (33), deprivation (34), childhood and lifetime cumulative socio-economic status (SES) (35) and education (36) appear to be stronger among men. However, concomitant social factors such as race and education can interact with sex to affect health outcomes in more complex ways that are not simply additive or multiplicative. Adopting an intersectionality framework offers a more nuanced understanding of how complex, co-existing effects of sex and social locations determine subjective health. Such a framework should aid in addressing social opportunities and constraints arising from sex, that is, in addressing gender, a much theorized but difficult to measure social determinant of health (37, 38). With roots in sociology and the study of inequality intersectionality frameworks assume that interlocking and overlapping social locations such as race, income, or education can interact with sex to jointly alter subjective and objective health outcomes. The focus of this study is on the three social locations of education, wealth, and rural/urban residence, all widely reported independent predictors of SRH (35), and whether these intersect with sex in shaping SRH among Canadian adults age 45+.

Although consensus is yet to be reached, various quantitative techniques for studying intersections of, for example, sex and social factors have recently been demonstrated. Utilizing structural equation modelling (SEM), Wang et al. (39) found that SES not only directly influences the health status of men and women differently, but also has differential indirect effects across sex groups through interactions with other social circumstances. Using European data Arpino et al. (40) examined the mediating effect of educational attainment on how early-life conditions shape older adults’ SRH and found a stronger effect among men (40). Using decomposition analysis techniques that partitioned gender inequities in SRH by SES, measures such as education and employment in Europe (41) and India (42) it appeared that the social vulnerability of older women in terms of educational attainment or access to well-paid jobs contributed to their poorer SRH. Multilevel (ML) analysis techniques offer another option for quantitative examination of intersectionality and have been used in several studies (43-45). ML models typically account for the ‘nesting’ or ‘clustering’ of individuals within geographic settings such as neighbourhoods. However, clusters examined can also include groupings by sex or social strata defined by levels of wealth and/or education attainment. Those sharing a cluster may well share certain characteristics that shape
values and behaviors. This commonality violates the assumption that each participant in a study is independent of all others, an assumption that is central to ordinary regression analysis. Multilevel analyses assess combined effects of, for example, sex and social factors simultaneously and interactively, not simply as additive or multiplicative interactions (45) and therefore are able to identify independent dimensions of stratification by social factors. ML analyses quantify cluster effects by estimating indicators such as the intra-class correlation coefficient (ICC); defined as the ratio of the between-cluster variance to the total variance. A large ICC suggests that variation between clusters has an important impact on an outcome and should be taken into account in etiological analyses. The Median Odds Ratio (MOR) is another measure of clustering. MOR quantifies between-cluster variations by exhaustively comparing any two randomly chosen persons, one from each cluster, offering more interpretable information for discrete outcomes in form of an Odds Ratio (46, 47). A larger MOR indicates higher variability between clusters.

Research on how intersections of sex and social factors shape perceived health of older adults is scarce. To address this gap our objectives were to 1) estimate the unbiased impact of sex and social circumstances on reported SRH in Canadian men and women age 45+; 2) explore interactions of three key dimensions of social identity (education, wealth, and rural/urban status) on the sex-SRH relationship; 3) explore intersections of sex and social factors, that is, of gender and SRH. By comparing findings across these analytic designs we hope to form a nuanced picture of how an older adult's multiple individual and social facets intersect to shape that health.

2. Methods

2.1. Settings and participants

The Canadian Longitudinal study on Aging (CLSA) includes a random sample of 30,097 community-dwelling adults aged 45 to 85 residing within a 25- to 50-km radius of 1 of the 11 data collection sites in 7 Canadian provinces (Raina et al., 2019). Individuals living in an institution or on a First Nations reserve or settlement, who were full-time members of the Canadian Armed Forces, were unable to speak French or English, or had cognitive impairment that could hamper answering of basic personal questions were excluded.

2.2. Sampling strategy

For the Comprehensive Cohort of the CLSA two sampling strategies were used. To recruit from provincial health registries (14% of the sample), randomly chosen eligible persons were sent a consent form to sign and return. For those recruited through random digit dialing (86% of the sample), a random sample of landline telephone numbers was selected for a given geographic area. After establishing eligibility among those answering calls, informed consent was obtained from all participants. The CLSA sample was stratified within provinces according to age group, sex, and distance from the data collection site, to ensure adequate representation of various demographic groups.
2.3. Data collection

After extensive training to ensure standardized data collection, interviewers administered questionnaires at participants' homes or at a data collection site. Physical examinations were conducted at the data collection site. Data were collected between 2010 and 2015.

2.4. Assessment of Self-rated Health (SRH)

Participants were asked to assess their health by answering the question, 'Would you say your health is excellent, very good, good, fair, poor?' For analysis, we collapsed the first three categories into a 'good' and the last two into a 'poor' SRH category.

2.5. Assessment of sex and main social factors (dimensions of social identity)

Information on sex, highest educational attainment (less than secondary school, secondary school graduation, some post-secondary, post-secondary graduation) and wealth (whether income fulfills basic needs) was collected via direct questions. Participants' residence postal codes were linked to dissemination area to classify place of residence into 'urban' and 'rural'. In Canada, the best proxy measure for place of residence in terms of studying health outcomes is rural/urban status (48).

2.6. Covariates

We wanted to identify all possible available predictors for perceptions of health in old age, therefore, we included a large number of variables in initial descriptive analyses.

Socio-demographic characteristics included age in years, marital status (currently married or common law, windowed, divorced, separated, single), country of birth, province, and household income as a categorical variable (<$20,000, $20,000-$49,999, $50,000-$99,999, $100,000-$149,999, ≥$150,000, Don't know/No answer/Refused). We also included 'frequency of community-related activity participation' as the measure of social participation and results of the medical outcomes study (MOS) social support scale (49) to indicate social support (see Appendix A for details).

Lifestyle factors included body mass index (BMI) classification [underweight<18.5 kg/m², normal weight (18.5-25 kg/m²), overweight (25–30 kg/m²), obese (>30 kg/m²)], smoking history (<100 cigarettes in lifetime or never smoked, former smoker, current smoker), drinking behavior in the past 12 months [did not drink in the last 12 months, occasional drinker, regular drinker (at least once a month)] and frequency of alcohol consumption (number of drinks per week). Nutritional risk was measured using the AB SCREENTM II (Abbreviated Seniors in the Community Risk Evaluation for Eating and Nutrition II) scale (50) that included questions on weight change, eating habits, difficulty eating, fruit, vegetable and fluid consumption, meal satisfaction, frequency of fast-food consumption, coffee and tea consumption, and food security. A modified version of the Physical Activity Scale for the Elderly (PASE) tool (51) was used to measure frequency of physical activity in the week prior to the interview and the amount of physical activity associated with one's work or volunteer activities.
Health status variables included questions about vision, hearing, as well as a modification of the Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) questions of the OARS Multidimensional Assessment Questionnaire (52). Additionally, the 10-item version of the Centre for Epidemiologic Studies Depression (CESD) scale was used to measure depression (53). Hand grip strength was measured objectively using a hand dynamometer (Appendix A). Finally, we included data on receiving and giving informal and formal care in the analysis.

### 2.7. Statistical analysis

Characteristics of participants were described across sex and SRH groups by calculation of means and standard deviations of continuous variables and frequency distributions of categorical variables. The significance of bivariate associations between covariates and sex and the outcome (SRH) were evaluated using t-test and Chi-square tests where appropriate. To estimate the unbiased effect of sex on the probabilities of reporting good SRH, we used Poisson regression models with robust variance. The most parsimonious models were constructed following the change in estimate method (54) to adjust only for true confounders. All variables that were significantly related to SRH or sex were entered in an initial main effect model. We started to trim this model by removing the variables with largest p values one by one. If the removal of a variable caused more than a 10% change in the sex-SRH association, the variable would be entered back into the model, even if the related p value were larger than 0.05. Results were reported as prevalence rate ratios (PRR) and corresponding 95% confidence intervals (95% CI) which are proper epidemiological effect estimates for cross-sectional data. We also tested for interactions between sex and other selected social factors (education, wealth, rural/urban status) for the outcome of SRH. None was significant; nevertheless, results were reported for the whole sample as well as stratified by sex. Following precedents (43, 44) to test the intersecting effects of social factors and sex on SRH we used multi-level analysis (MLA) to calculate Intra-class Correlation Coefficients (ICC) and Median Odds Ratios (MOR) for each of the four selected social identity factors and their combinations. We did not include the main effects of social strata in the model and only constructed a set of empty models (intercept only) in which the random effect clusters were defined by the four social identity strata (sex, education, wealth, rural/urban status).

All analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC, USA).

### 3. Results

#### Descriptive

Almost half of all participants were female and, overall, more than 90 percent perceived their health as good. There was no statistically significant difference in this perception between men and women (p = 0.066). With the exception of availability of social support, province of residence and nutrition, distributions of all other variables differed significantly for men and women (Table 1).
| Variable                        | Description                               | Female     | Male       | P.value |
|--------------------------------|-------------------------------------------|------------|------------|---------|
|                                |                                            | 15320 (50.90%) | 14777 (49.10%) | -       |
| Sex                            |                                            | 14777 (49.10%) | 15320 (50.90%) | -       |
| Age                            | In years (mean, SD)                        | 62.8 (10.2)  | 63.2 (10.3)  | 0.001   |
| Self-rated Health              | Good health                               | 13939 (91.05%) | 13353 (90.44%) | 0.066   |
|                                | Poor health                               | 1370 (8.95%)  | 1412 (9.56%)  |         |
| Self-rated Mental health       | Good health                               | 14427 (94.24%) | 13990 (94.77%) | 0.046   |
|                                | Poor health                               | 881 (5.76%)   | 772 (5.23%)   |         |
| Chronic conditions             | At least 1 chronic condition              | 14347 (94.17%) | 13286 (90.68%) | < 0.0001|
|                                | No chronic conditions                      | 888 (5.83%)   | 1365 (9.32%)  |         |
| Social support availability    | Higher = better (mean, SD)                | 99.4 (130.1)  | 99.8 (130.4)  | 0.125   |
| Social support participation   | Did not participate in community related activity | 16 (0.10%)    | 20 (0.14%)    | < 0.0001|
|                                | Participated in community related activity at least 1/year | 173 (1.13%)    | 254 (1.72%)    |         |
|                                | Participated in community related activity at least 1/month | 1605 (10.48%)  | 2172 (14.70%)  |         |
|                                | Participated in community related activity at least 1/week | 10623 (69.34%) | 9904 (67.02%)  |         |
|                                | Participated in community related activity at least 1/day | 2876 (18.77%)  | 2397 (16.22%)  |         |
| Country of birth               | Canada                                    | 12774 (83.40%) | 11870 (80.33%) | < 0.0001|
|                                | Other                                     | 2543 (16.60%)  | 2907 (19.67%)  |         |

1. Numbers inside parentheses are column percentage or SD
2. P values are from t-test or chi-square test where appropriate.
| Variable                     | Description                               | Female          | Male            | P.value |
|------------------------------|-------------------------------------------|-----------------|-----------------|---------|
| Province of residence        | Alberta                                   | 1517 (9.90%)    | 1440 (9.74%)    | 0.294   |
|                              | British Columbia                          | 3158 (20.61%)   | 3096 (20.95%)   |         |
|                              | Manitoba                                  | 1594 (10.40%)   | 1519 (10.28%)   |         |
|                              | Newfoundland/Labrador                      | 1132 (7.39%)    | 1082 (7.32%)    |         |
|                              | Nova Scotia                                | 1549 (10.11%)   | 1529 (10.35%)   |         |
|                              | Ontario                                   | 3207 (20.93%)   | 3211 (21.73%)   |         |
|                              | Quebec                                    | 3163 (20.65%)   | 2900 (19.63%)   |         |
| Location                     | Urban                                     | 13828 (91.48%)  | 13467 (92.22%)  | 0.032   |
|                              | Rural                                     | 1288 (8.52%)    | 1136 (7.78%)    |         |
| Marital status               | Single                                    | 1456 (9.50%)    | 1198 (8.11%)    | <0.0001 |
|                              | Married/in a common law relationship      | 9160 (59.59%)   | 11491 (77.76%)  |         |
|                              | Widowed                                   | 2079 (13.57%)   | 730 (4.94%)     |         |
|                              | Divorced                                  | 2180 (14.23%)   | 1005 (6.80%)    |         |
|                              | Separated                                 | 440 (2.87%)     | 350 (2.37%)     |         |
| Education level              | Less than secondary school graduation     | 918 (5.99%)     | 725 (4.91%)     | <0.0001 |
|                              | Secondary school graduation, no post-secondary | 1610 (10.51%)   | 1229 (8.32%)    |         |

1. Numbers inside parentheses are column percentage or SD
2. P values are from t-test or chi-square test where appropriate.
| Variable         | Description                                           | Female     | Male       | P.value |
|------------------|-------------------------------------------------------|------------|------------|---------|
|                  | Some post-secondary education                         | 1164 (7.60%) | 1074 (7.27%) |         |
| Wealth           | Post-secondary degree/diploma                         | 11609 (75.78%) | 11718 (79.30%) |         |
|                  | Very well                                             | 7680 (50.13%) | 7848 (53.11%) | < 0.0001|
|                  | Adequately                                            | 5387 (35.16%) | 5090 (34.45%) |         |
|                  | With some difficulty                                  | 1042 (6.80%) | 781 (5.29%) |         |
|                  | Not very well                                         | 250 (1.63%) | 220 (1.49%) |         |
|                  | Totally inadequately                                  | 117 (0.76%) | 83 (0.56%) |         |
| Income           | Less than $20,000                                     | 3174 (20.72%) | 1199 (8.11%) | < 0.0001|
|                  | $20,000 or more, but less than $50,000                | 6053 (39.51%) | 4485 (30.35%) |         |
|                  | $50,000 or more, but less than $100,000               | 4062 (26.51%) | 5634 (38.13%) |         |
|                  | $100,000 or more, but less than $150,000              | 738 (4.82%) | 1779 (12.04%) |         |
|                  | $150,000 or more                                      | 326 (2.13%) | 1139 (7.71%) |         |
| Smoking          | Daily smoker                                          | 1261 (8.23%) | 1449 (9.81%) | < 0.0001|
|                  | Occasional smoker or former daily smoker              | 7783 (50.80%) | 6459 (43.71%) |         |
|                  | < 100 cigarettes in lifetime/non smoke                | 6276 (40.97%) | 6868 (46.48%) |         |
| Alcohol consumption | Regular drinker (at least once/month)              | 10567 (68.98%) | 11672 (78.99%) | < 0.0001|
|                  | Occasional drinker                                    | 2409 (15.72%) | 1296 (8.77%) |         |

1. Numbers inside parentheses are column percentage or SD
2. P values are from t-test or chi-square test where appropriate.
| Variable                        | Description                  | Female                      | Male                      | P.value  |
|--------------------------------|------------------------------|-----------------------------|---------------------------|----------|
|                                | Female Мale (P.value)        | Female Мale (P.value)       | Female Мale (P.value)     |          |
| Did not drink in the last 12 months | 1884 (12.30%) 1543 (10.44%) |                             |                            |          |
| Alcohol consumption frequency   | Almost every day             | 1904 (12.81%) 2941 (20.27%) | < 0.0001                  |          |
|                                | 4–5 times/week               | 1310 (8.82%) 1684 (11.60%)  |                            |          |
|                                | 2–3 times/week               | 2847 (19.16%) 3286 (22.65%) |                            |          |
|                                | 1 time/week                  | 1684 (11.33%) 1612 (11.11%) |                            |          |
|                                | Occasionally                 | 5231 (35.20%) 3444 (23.73%) |                            |          |
|                                | Never                        | 1884 (12.68%) 1543 (10.63%) |                            |          |
| Nutrition                      | Higher = better              | 37.3 (18.5) 37.5 (19.5) 0.191|                            |          |
| Physical activity-             | Never                        | 10492 (68.49%) 9848 (66.64%)| < 0.0001                  |          |
| frequency last week            | Seldom (1–2 days)            | 1649 (10.76%) 1322 (8.95%)  |                            |          |
|                                | Sometimes (3–4 days)         | 1422 (9.28%) 1610 (10.90%)  |                            |          |
|                                | Often (5–7 days)             | 1075 (7.02%) 1352 (9.15%)   |                            |          |
| Physical activity-             | < 30 minutes                 | 1905 (12.43%) 1957 (13.24%) | < 0.0001                  |          |
| hours/day                      | 30 minutes to 1 hour         | 1391 (9.08%) 1376 (9.31%)   |                            |          |
|                                | 1 hour to 2 hours            | 763 (4.98%) 844 (5.71%)     |                            |          |
|                                | 2 hours to 4 hours           | 69 (0.45%) 85 (0.58%)       |                            |          |
|                                | 4 hours +                    | 9 (0.06%) 14 (0.09%)        |                            |          |

1. Numbers inside parentheses are column percentage or SD
2. P values are from t-test or chi-square test where appropriate.
| Variable                        | Description                                      | Female   | Male     | P.value   |
|--------------------------------|--------------------------------------------------|----------|----------|-----------|
| Physical activity at work      | Mainly sitting with slight arm movements         | 2882 (18.81%) | 3238 (21.91%) | < 0.0001  |
|                                | Sitting and standing with some walking           | 3090 (20.17%) | 2652 (17.95%) |            |
|                                | Walking with some light handling of materials    | 1888 (12.32%) | 1830 (12.38%) |            |
|                                | Walking and heavy manual work                    | 131 (0.86%) | 462 (3.13%) |            |
| ADL + IADL                     | Higher = independent for more ADL and IADL (mean, SD) | 0.0082 (0.1710) | 0.0043 (0.0702) | 0.002     |
| Depression                     | Higher = more depression symptoms (mean, SD)     | 3.9 (2.6) | 3.5 (2.6) | < 0.0001  |
| BMI                            | Underweight                                      | 164 (1.07%) | 53 (0.36%) | < 0.0001  |
|                                | Normal                                           | 5331 (34.80%) | 3532 (23.90%) |            |
|                                | Overweight                                       | 5302 (34.61%) | 6786 (45.92%) |            |
|                                | Obese Class I                                    | 2663 (17.38%) | 3157 (21.36%) |            |
|                                | Obese Class II                                   | 1131 (7.38%) | 847 (5.73%) |            |
|                                | Obese Class III                                  | 659 (4.30%) | 336 (2.27%) |            |
| Vision                         | Excellent                                        | 3362 (21.95%) | 3488 (23.60%) |            |
|                                | Very Good                                        | 5975 (39.00%) | 5775 (39.08%) | 0.001     |
|                                | Good                                             | 4758 (31.06%) | 4414 (29.87%) |            |
|                                | Fair                                             | 1010 (6.59%) | 947 (6.41%) |            |
|                                | Poor                                             | 200 (1.31%) | 149 (1.01%) |            |

1. Numbers inside parentheses are column percentage or SD
2. P values are from t-test or chi-square test where appropriate.
| Variable           | Description                                      | Female  | Male    | P.value |
|-------------------|--------------------------------------------------|---------|---------|---------|
| Hearing           | Excellent                                        | 3931    | 2735    | < 0.0001|
|                   |                                                  | (25.665)| (18.51%)|         |
|                   | Very Good                                        | 5404    | 4686    |         |
|                   |                                                  | (35.27%)| (31.71%)|         |
|                   | Good                                             | 4700    | 5179    |         |
|                   |                                                  | (30.68%)| (35.05%)|         |
|                   | Fair                                             | 1107    | 1863    |         |
|                   |                                                  | (7.22%)  | (12.61%)|         |
|                   | Poor                                             | 164     | 301     |         |
|                   |                                                  | (1.07%)  | (2.04%)  |         |
| Grip strength     | Higher = stronger grip (mean, SD)                | 26.5130 | 43.7429 | < 0.0001|
|                   |                                                  | (6.0016)| (9.7894)|         |
| Formal health care services | Received formal health care services            | 902     | 560     | < 0.0001|
|                   |                                                  | (5.89%)  | (3.79%)  |         |
|                   | Did not receive formal health care services      | 14411   | 14207   |         |
|                   |                                                  | (94.07%)| (96.14%)|         |
| Informal health care services | Received informal health care services        | 2043    | 1310    |         |
|                   |                                                  | (13.34%)| (8.87%)  |         |
|                   | Did not receive informal health care services   | 13271   | 13460   |         |
|                   |                                                  | (86.63%)| (91.09%)|         |
| Care services     | Did not receive any health care services         | 12857   | 13170   | < 0.0001|
|                   |                                                  | (83.92%)| (89.12%)|         |
|                   | Received formal health care services only        | 409     | 282     |         |
|                   |                                                  | (2.67%)  | (1.91%)  |         |
|                   | Received informal health care services only      | 1551    | 1033    |         |
|                   |                                                  | (10.12%)| (6.99%)  |         |
|                   | Received both formal and informal health care services | 491   | 277     |         |
|                   |                                                  | (3.20%)  | (1.87%)  |         |
| Care giving       | Did provide assistance for others                | 7215    | 5828    | < 0.0001|
|                   |                                                  | (47.10%)| (39.44%)|         |
|                   | Did not provide assistance for others            | 8093    | 8939    |         |
|                   |                                                  | (52.83%)| (60.49%)|         |
| Hours care giving | Average hours/week caregiving for others (mean, SD) | 15.9    | 11.3    |         |
|                   |                                                  | (28.1)  | (21.7)  |         |

1. Numbers inside parentheses are column percentage or SD

2. P values are from t-test or chi-square test where appropriate.
Frequencies of reporting good SRH also varied significantly across all other characteristics considered with the exception of physical activity at work, country of birth, province of residence and rural/urban status (Table 2).
### Table 2
Characteristics of the CLSA sample by the SRH Status

| Variable                              | Description                  | Good SRH   | Poor SRH   | Pvalue |
|---------------------------------------|------------------------------|------------|------------|--------|
| **Sex**                               |                              |            |            |        |
| Female                                |                              | 13939 (91.05%) | 1370 (8.95%) | 0.0661 |
| Male                                  |                              | 13353 (90.44%) | 1412 (9.56%) |        |
| **Age**                               | In years (mean, SD)          | 62.9 (10.2) | 63.4 (10.4) | 0.0004 |
| **Self-rated Mental health**           | Good health                  | 26448 (93.13%) | 1951 (6.87%) | 0.0107 |
|                                       | Poor health                  | 830 (50.27%) | 821 (49.73%) |        |
| **Chronic conditions**                | At least 1 chronic condition | 24878 (90.10%) | 2733 (9.90%) | < 0.0001 |
|                                       | No chronic conditions        | 2216 (98.40%) | 36 (1.60%)   |        |
| **Social support availability**       | Higher = better (mean, SD)   | 99.1 (125.4) | 104.5 (169.7) | < 0.0001 |
| **Social support participation**      | Did not participate in community related activity | 31 (68.89%) | 14 (31.11%) |        |
|                                       | Participated in community related activity at least 1/year | 306 (71.66%) | 121 (28.34%) | < 0.0001 |
|                                       | Participated in community related activity at least 1/month | 3205 (84.97%) | 567 (15.03%) | < 0.0001 |
|                                       | Participated in community related activity at least 1/week | 18808 (91.69%) | 1704 (8.31%) |        |
|                                       | Participated in community related activity at least 1/day | 4906 (93.08%) | 365 (6.92%) |        |
| **Country of birth**                  | Other                        | 3086 (91.33%) | 293 (8.67%) | 0.4885 |
|                                       | Canada                       | 24203 (90.68%) | 2489 (9.32%) |        |
| **Province of residence**             | Alberta                      | 2680 (90.72%) | 274 (9.28%) | 0.1852 |

1. Numbers inside parentheses are row percentage or SD
2. P values are from t-test or chi-square test where appropriate
| Variable                  | Description                                      | Good SRH | Poor SRH | Pvalue |
|---------------------------|--------------------------------------------------|----------|----------|--------|
|                          |                                                  | British Columbia | 5647 (90.35%) | 603 (9.65%) |        |
|                          |                                                  | Manitoba       | 2825 (90.81%) | 286 (9.19%) |        |
|                          |                                                  | Newfoundland/Labrador | 1999 (90.33%) | 214 (9.67%) |        |
|                          |                                                  | Nova Scotia    | 2783 (90.53%) | 291 (9.47%) |        |
|                          |                                                  | Ontario        | 5878 (91.66%) | 535 (8.34%) |        |
|                          |                                                  | Quebec         | 5480 (90.44%) | 579 (9.56%) |        |
| Location                 | Urban                                            | 24732 (90.68%) | 2542 (9.32%) | 0.0799 |
|                          | Rural                                            | 2224 (91.82%) | 198 (8.18%) |        |
| Marital status           | Single                                           | 2305 (86.85%) | 349 (13.15%) | <0.0001|
|                          | Married/in a common law relationship             | 19004 (92.09%) | 1632 (7.91%) |        |
|                          | Widowed                                          | 2520 (89.84%) | 285 (10.16%) |        |
|                          | Divorced                                         | 2763 (86.86%) | 418 (13.14%) |        |
|                          | Separated                                        | 692 (87.59%) | 98 (12.41%) |        |
| Education level          | Less than secondary school graduation             | 1317 (80.30%) | 323 (19.70%) | <0.0001|
|                          | Secondary school graduation, no post-secondary    | 2536 (89.36%) | 302 (10.64%) |        |
|                          | Some post-secondary education                    | 1959 (87.61%) | 277 (12.39%) |        |
|                          | Post- secondary degree/diploma                   | 21440 (91.98%) | 1870 (8.02%) |        |
| Wealth                   | Very well                                        | 14676 (94.57%) | 843 (5.43%) | <0.0001|

1. Numbers inside parentheses are row percentage or SD
2. P values are from t-test or chi-square test where appropriate
| Variable | Description | Good SRH | Poor SRH | Pvalue |
|----------|-------------|----------|----------|--------|
| Adequately | 9388 (89.69%) | 1079 (10.31%) | | |
| With some difficulty | 1478 (81.08%) | 345 (18.92%) | | |
| Not very well | 328 (69.78%) | 142 (30.21%) | | |
| Totally inadequately | 119 (59.50%) | 81 (40.50%) | | |
| Income | | | | <0.0001 |
| Less than $20,000 | 3522 (80.56%) | 850 (19.44%) | | |
| $20,000 or more, but less than $50,000 | 9529 (90.52%) | 998 (9.48%) | | |
| $50,000 or more, but less than $100,000 | 9102 (93.93%) | 588 (6.07%) | | |
| $100,000 or more, but less than $150,000 | 2400 (95.35%) | 117 (4.65%) | | |
| $150,000 or more | 1395 (95.29%) | 69 (4.71%) | | |
| Smoking | Daily smoker | 2243 (82.80%) | 466 (17.20%) | <0.0001 |
| Occasional smoker or former daily smoker | 13230 (92.96%) | 1002 (7.04%) | | |
| < 100 cigarettes in lifetime/non smoker | 11818 (89.99%) | 1314 (10.01%) | | |
| Alcohol consumption | Regular drinker (at least once/month) | 20699 (93.12%) | 1529 (6.88%) | <0.0001 |
| Occasional drinker | 3134 (84.75%) | 564 (15.25%) | | |
| Did not drink in the last 12 months | 2828 (82.62%) | 595 (17.38%) | | |
| Alcohol consumption frequency | Almost every day | 4518 (93.41%) | 319 (6.59%) | <0.0001 |
| 4–5 times/week | 2838 (94.79%) | 156 (5.21%) | | |
| 2–3 times/week | 5793 (94.49%) | 338 (5.51%) | | |

1. Numbers inside parentheses are row percentage or SD
2. P values are from t-test or chi-square test where appropriate
| Variable                        | Description                               | Good SRH | Poor SRH | Pvalue |
|--------------------------------|-------------------------------------------|----------|----------|--------|
|                                |                                            |          |          |        |
|                                | 1 time/week                               | 3051 (92.57%) | 1035 (7.43%) |        |
|                                | Occasionally                              | 7633 (88.06%) | 1035 (11.94%) |        |
|                                | Never                                     | 2828 (82.62%) | 595 (17.38%) |        |
|                                | Nutrition                                 | Higher = better | 37.97 (18.21) | 30.97 (24.73) | < 0.0001 |
|                                | Physical activity-frequency last week      | Never | 18305 (90.06%) | 2021 (9.94%) | < 0.0001 |
|                                |                                            | Seldom (1–2 days) | 2791 (93.97%) | 179 (6.03%) |        |
|                                |                                            | Sometimes (3–4 days) | 2887 (95.28%) | 143 (4.72%) |        |
|                                |                                            | Often (5–7 days) | 2236 (92.24%) | 188 (7.76%) |        |
|                                | Physical activity-hours/day                | < 30 minutes | 3584 (92.90%) | 274 (7.10%) | 0.00004 |
|                                |                                            | 30 minutes to 1 hour | 2610 (94.36%) | 156 (5.64%) |        |
|                                |                                            | 1 hour to 2 hours | 1537 (95.70%) | 69 (4.30%) |        |
|                                |                                            | 2 hours to 4 hours | 148 (96.10%) | 6 (3.90%) |        |
|                                |                                            | 4 hours + | 20 (86.96%) | 3 (13.04%) |        |
|                                | Physical activity at work                  | Mainly sitting with slight arm movements | 5730 (93.67%) | 387 (6.33%) | 0.1775 |
|                                |                                            | Sitting and standing with some walking | 5410 (94.22%) | 332 (5.78%) |        |
|                                |                                            | Walking with some light handling of materials | 3470 (93.38%) | 246 (6.62%) |        |
|                                |                                            | Walking and heavy manual work | 547 (92.40%) | 45 (7.60%) |        |
|                                | ADL + IADL                                 | Higher = independent for more ADL and IADL (mean, SD) | 0.0051 (0.1304) | 0.0176 (0.1421) | < 0.0001 |

1. Numbers inside parentheses are row percentage or SD
2. P values are from t-test or chi-square test where appropriate
| Variable     | Description                          | Good SRH | Poor SRH | Pvalue |
|--------------|--------------------------------------|----------|----------|--------|
| Depression   | Higher = more depression symptoms (mean, SD) | 3.6 (2.6) | 5.1 (2.6) | < 0.0001 |
| BMI          | Underweight                          | 177 (81.57%) | 40 (18.43%) | < 0.0001 |
|              | Normal                               | 8352 (94.32%) | 503 (5.68%) |       |
|              | Overweight                           | 11260 (93.23%) | 818 (6.77%) |       |
|              | Obese Class I                        | 5110 (87.86%) | 706 (12.14%) |       |
|              | Obese Class II                       | 1610 (81.40%) | 368 (18.60%) |       |
|              | Obese Class III                      | 692 (69.92%) | 302 (30.38%) |       |
| Vision       | Excellent                            | 6435 (94.04%) | 408 (5.96%) | < 0.0001 |
|              | Very Good                            | 10963 (93.37%) | 778 (6.63%) |       |
|              | Good                                 | 8102 (88.36%) | 1067 (11.64%) |       |
|              | Fair                                 | 1521 (77.72%) | 436 (22.28%) |       |
|              | Poor                                 | 254 (73.41%) | 92 (26.59%) |       |
| Hearing      | Excellent                            | 6189 (92.91%) | 472 (7.09%) | < 0.0001 |
|              | Very Good                            | 9412 (93.30%) | 676 (6.70%) |       |
|              | Good                                 | 8842 (89.62%) | 1024 (10.38%) |       |
|              | Fair                                 | 2472 (83.34%) | 494 (16.66%) |       |
|              | Poor                                 | 356 (76.56%) | 109 (23.44%) |       |
| Grip strength| Higher = stronger grip (mean, SD)    | 35.4 (11.8) | 33.1 (11.8) | < 0.0001 |

1. Numbers inside parentheses are row percentage or SD
2. P values are from t-test or chi-square test where appropriate
## Variable Description

| Variable | Description                                              | Good SRH | Poor SRH | Pvalue |
|----------|-----------------------------------------------------------|----------|----------|--------|
|          |                                                           | (         | (        |        |
| Formal health care services | Received formal health care services | 1022 (70.00%) | 438 (30.00%) | < 0.0001 |
|          | Did not receive formal health care services              | 26256 (91.81%) | 2342 (8.19%) |        |
| Informal health care services | Received informal health care services                  | 2533 (75.66%) | 815 (24.34%) | < 0.0001 |
|          | Did not receive informal health care services            | 24751 (92.65%) | 1963 (7.35%) |        |
| Care services | Did not receive any health care services                 | 24214 (93.09%) | 1797 (6.91%) | < 0.0001 |
|          | Received formal health care services only                | 526 (76.23%) | 164 (23.77%) |        |
|          | Received informal health care services only              | 2037 (78.95%) | 543 (21.05%) |        |
|          | Received both formal and informal health care            | 495 (64.54%) | 272 (35.46%) |        |
| Care giving | Did provide assistance for others                       | 11907 (91.34%) | 1129 (8.66%) | 0.0019 |
|          | Did not provide assistance for others                    | 15364 (90.29%) | 1652 (9.71%) |        |
| Hours care giving | Average hours/week caregiving for others (mean, SD)   | 13.6 (25.1) | 16.4 (30.3) | < 0.0001 |

1. Numbers inside parentheses are row percentage or SD
2. P values are from t-test or chi-square test where appropriate

The unadjusted Poisson model showed that compared to men, women were 7 percent less likely to report poor SRH (PRR = 0.93; 95% CI: 0.87, 1.00). After adjustment for true confounders, identified via a well-formulated model specified following change in estimate processes, the bivariate marginally significant association between sex and SRH became significant and much stronger (PRR = 0.57; 95%CI: 0.51, 0.64). In other words, after accounting for true confounders women were 43 percent less likely to report poor SRH. When findings for women and men were separated in sex stratified models (Table 3) the following characteristics or variables aligned significantly with reports of poor health for both men and women: more chronic conditions, lower social participation, lower wealth (income adequacy), poorer nutrition, depression, impaired hearing, and weaker grip.
Table 3
Results of sex-stratified Poisson models (outcome = poor SRH)

| Variable                        | Description                        | PRR (All) | PRR (Men) | PRR (Women) |
|---------------------------------|------------------------------------|-----------|-----------|-------------|
| Sex                             | Female vs male                     | 0.57 (0.51–0.64) |           |             |
| Age                             | In years                           | 0.983 (0.978–0.987) | 0.980 (0.973–0.988) | 0.982 (0.975–0.989) |
| Chronic conditions              | At least 1 chronic condition       | 5.95 (2.73–5.70) | 3.15 (1.96–5.07) | 5.30 (2.44–11.52) |
|                                 | No chronic conditions              | Ref.      | Ref.      | Ref.        |
| Social support availability     | Availability of social support     | 0.994 (0.992–0.996) | 0.994 (0.990–0.998) | 0.992 (0.989–0.996) |
| Social support participation    | Did not participate in community related activity | 1.50 (0.79–2.79) | 1.79 (0.57–5.63) | 1.36 (0.62–2.69) |
|                                 | Participated in community related activity at least 1/year | 1.54 (1.20–2.79) | 1.51 (1.05–2.18) | 2.00 (1.35–2.99) |
|                                 | Participated in community related activity at least 1/month | 1.58 (1.37–1.82) | 1.52 (1.21–1.91) | 1.72 (1.36–2.19) |
|                                 | Participated in community related activity at least 1/week | 1.21 (1.07–1.38) | 1.09 (0.89–1.32) | 1.34 (1.09–1.64) |
|                                 | Participated in community related activity at least 1/day | Ref. | Ref. | Ref. |
| Education level                 | Less than secondary school graduation | 1.30 (1.13–1.49) | - | 1.35 (1.10–1.65) |
|                                 | Secondary school graduation, no post-secondary | 0.98 (0.86–1.11) | - | 1.05 (0.86–1.28) |

PRR = prevalence rate ratio
Numbers inside parentheses are 95%CI
| Variable                  | Description                                      | PRR All (0.97–1.26) | PRR (Men) (0.97–2.51) | PRR (Women) (0.97–2.41) |
|--------------------------|--------------------------------------------------|----------------------|------------------------|--------------------------|
| Education                | Some post-secondary education                    | 1.10                 | -                      | 1.19                    |
|                          | Post-secondary education                          |                      |                        |                          |
| Wealth                   | Totally inadequately                              | 1.76 (1.40–2.23)     | 1.68 (1.13–2.51)       | 1.69 (1.18–2.41)         |
| (how well does your income | Not very well                                     | 1.77 (1.47–2.13)     | 1.81 (1.34–2.45)       | 1.56 (1.14–2.14)         |
| satisfy your basic needs?)| With some difficulty                              | 1.34 (1.05–1.54)     | 1.18 (0.93–1.50)       | 1.35 (1.09–1.67)         |
|                          | Adequately                                       | 1.24 (1.13–1.36)     | 1.12 (0.96–1.30)       | 1.26 (1.08–1.48)         |
|                          | Very well                                        | Ref.                 | Ref.                   | Ref.                     |
| Income                   | Less than $20,000                                 | 1.32 (1.12–1.56)     | 1.75 (1.30–2.34)       | 1.24 (0.96–1.59)         |
|                          | $20,000 or more, but less than $50,000            | 0.97 (0.83–1.13)     | 1.33 (1.03–1.72)       | 0.86 (0.67–1.11)         |
|                          | $50,000 or more, but less than $100,000           | 0.85 (0.72–0.99)     | 1.02 (0.79–1.32)       | 0.77 (0.56–0.97)         |
|                          | $100,000 or more, but less than $150,000          | 0.74 (0.59–0.93)     | 0.93 (0.68–1.28)       | 0.61 (0.36–1.03)         |
|                          | $150,000 or more                                 | Ref.                 | Ref.                   | Ref.                     |
| Smoking                  | Daily smoker                                      | 1.41 (1.24–1.60)     | 1.41 (1.15–1.73)       | 1.50 (1.24–1.83)         |
|                          | Occasional smoker or former daily smoker          | 1.25 (1.15–1.34)     | 1.32 (1.14–1.52)       | 1.05 (1.02–1.34)         |

PRR = prevalence rate ratio

Numbers inside parentheses are 95%CI
| Variable                               | Description                                      | PRR All         | PRR (Men)        | PRR (Women)       |
|----------------------------------------|--------------------------------------------------|-----------------|------------------|-------------------|
| < 100 cigarettes in lifetime/non-smoker | Ref.                                             | Ref.            | Ref.             | Ref.              |
| Alcohol consumption                    | Regular drinker (at least once/month)            | 0.65 (0.59–0.72) | 0.78 (0.66–0.93) | 0.59 (0.50–0.69)  |
|                                        | Occasional drinker                               | 0.91 (0.81–1.02) | 1.07 (0.86–1.34) | 0.84 (0.71–0.99)  |
|                                        | Did not drink in the last 12 months              | Ref.            | Ref.             | Ref.              |
| Nutrition                              | Higher = healthier nutrition                      | 0.997 (0.995–0.998) | 0.996 (0.993–0.998) | 0.996 (0.994–0.998) |
| Depression                             | Measure of depressive symptoms                   | 1.019 (1.014–1.024) | 1.023 (1.022–1.036) | 1.021 (1.015–1.027) |
| BMI                                    | Underweight                                      | 1.77 (1.25–2.51) | 2.10 (1.20–3.66) | 1.69 (1.01–2.82)  |
|                                        | Normal                                           | Ref.            | Ref.             | Ref.              |
|                                        | Overweight                                       | 1.11 (0.98–1.24) | 1.00 (0.83–1.21) | 1.31 (1.08–1.58)  |
|                                        | Obese                                            | 2.06 (1.85–2.29) | 2.22 (1.86–2.65) | 2.28 (1.91–2.72)  |
| Vision                                 | Poor                                             | 1.76 (1.56–1.98) | -                | 1.80 (1.48–2.18)  |
|                                        | Good                                             | 1.38 (1.26–1.51) | -                | 1.33 (1.15–1.54)  |
|                                        | Excellent                                        | Ref.            | -                | Ref.              |
| Hearing                                | Poor                                             | 1.78 (1.59–1.98) | 1.99 (1.69–2.33) | 1.76 (1.45–2.12)  |

PRR = prevalence rate ratio

Numbers inside parentheses are 95%CI
| Variable                        | Description                                                                 | PRR All          | PRR (Men)      | PRR (Women)    |
|--------------------------------|------------------------------------------------------------------------------|------------------|----------------|----------------|
|                                |                                                                              | (Men)            | (Women)       |                |
|                                | Good                                                                         | 1.22 (1.11–1.34) | 1.39 (1.20–1.62) | 1.16 (1.00–1.33) |
|                                | Excellent                                                                    | Ref.             | Ref.           | Ref.           |
| Grip strength                  | In Kg                                                                         | 0.983 (0.977–0.988) | 0.986 (0.979–0.993) | 0.975 (0.963–0.987) |
| Care services                  | Received both formal and informal health care services                        | 2.87 (2.51–3.29) | 3.27 (2.55–4.18) | 2.71 (2.20–3.32) |

PRR = prevalence rate ratio  
Numbers inside parentheses are 95% CI

Somewhat unexpectedly, in both sex groups: 1) drinking was negatively associated with poor SRH, that is, drinkers rated their health as better than did non-drinkers and; 2) middle levels of income were associated with better SRH than were high income levels (> $150,000 Canadian).

Education and vision were significant predictors only for women and, therefore, were excluded from the ‘men’ model. Other variables had very different effects on SRH for each sex: 1) number of chronic conditions, while highly associated for all, was a much stronger predictor of poor SRH in women (PRR = 5.30; 95% CI: 2.44, 11.52 in women; PRR = 3.15; 95% CI: 1.96, 5.07 in men); 2) the detrimental effect of very low income (< $20,000) was strong for men and not significant for women (PRR = 1.75; 95% CI: 1.30, 2.34; PRR = 1.24; 95% CI: 0.96, 1.59; respectively); 3) while for men being underweight was associated with approximately twice the likelihood of reporting poor SRH (PRR = 2.10; 95% CI: 1.20, 3.66), among women, being overweight or obese were stronger predictors; 4) receiving both types of care (formal and informal) was strongly associated with poor SRH for all, but more so for men than women (PRR = 3.27; 95% CI: 2.55, 4.18; PRR = 2.71; 95% CI: 2.20, 3.32; respectively).

In intercept only multilevel models when single clusters were examined and compared wealth explained the greatest proportion of variability in SRH (strongest cluster effect). Almost 21 percent of differences in SRH was explained via clusters defined by ‘wealth group’ differences, alone. The next strongest cluster effect (5%) was observed for education groups. Cluster effects from sex or rural/urban status groupings were very small, explaining only 0.12 and 0.2 percent, respectively. To assess intersectionality, after looking at strata defined by combinations of two of the above factors, the largest ICCs were for ‘education and wealth’ and for ‘sex and wealth’ (almost 15%). Adding either of sex or education to wealth grouping factors lowered the cluster effect of wealth from 21 percent to 15 percent. Despite very small random effects from ‘rural/urban status’ alone, the largest cluster effect (13.6%) from the strata shaped
by three factors was for ‘sex, wealth, and rural/urban status’ and not ‘sex, wealth, and education’, suggesting complex, intersecting impacts from these categories rather than simple additive or multiplicative interaction effects. All cluster effects were verified by calculating MORs (Table 4).

Table 4
Cluster effects of sex and social factors and their combinations

| Random effect                               | ICC  | P value for the random intercept | MOR  |
|---------------------------------------------|------|---------------------------------|------|
| Sex                                         | 0.1% | 0.1408                          | 1.04 |
| Education                                   | 4.7% | < 0.0001                        | 1.46 |
| Wealth                                      | 20.6%| < 0.0001                        | 2.40 |
| Rural/urban status (RUS)                    | 0.2% | 0.1286                          | 1.08 |
| Sex & Education                             | 3.4% | < 0.0001                        | 1.38 |
| Sex & Wealth                                | 14.8%| < 0.0001                        | 2.05 |
| Sex & RUS                                   | 0.1% | 0.01112                         | 1.06 |
| Education & Wealth                          | 14.9%| < 0.0001                        | 2.06 |
| Education & RUS                             | 3.2% | < 0.0001                        | 1.37 |
| Wealth & RUS                                | 15.3%| < 0.0001                        | 2.08 |
| Sex, Education & Wealth                     | 13.2%| < 0.0001                        | 1.96 |
| Sex, Education & RUS                        | 2.9% | < 0.0001                        | 1.35 |
| Sex, Wealth & RUS                           | 13.6%| < 0.0001                        | 1.98 |
| Education, Wealth & RUS                     | 7.5% | < 0.0001                        | 1.63 |
| Sex, Education, Wealth & RUS                | 13.4%| < 0.0001                        | 1.97 |

ICC = Intra-class Correlation Coefficient
MOR = Median Odds Ratio

4. Discussion

The interplay between who one is (individual characteristics), one’s lived circumstances (social and contextual characteristics), and health is well documented, strong, and of particular importance with aging and concomitant accumulation of opportunities and constraints. The congruence of measures of objective and subjective health is also robust. Less clear is how those interconnections between lived realities, themselves, and individual biology actually shape health. We have gone beyond simply dichotomizing sex with its inevitable assumption that, for example, all women are the same and different
from all men, and found that intersections of sex and social strata or locations deepen explanations for reported health differences. Guided by social determinants of health theories (28) and conceptual models that explain population variations in SRH (6, 55) we theorized health to be a function of the interplay between sex, individual, social, and contextual factors. Simple regression models that only estimate fixed effects of specified factors are not able to examine this complexity and therefore, an intersectionality approach is warranted and valuable (37, 56).

We started our analyses by constructing well-formulated Poisson regression models. Although diminished by each of chronic conditions, lower social participation, lower wealth, poorer nutrition or hearing, and lower grip strength, overall, the CLSA population of 45 + year old Canadians perceived themselves as healthy.

Some findings, such as greater SRH among those who consume alcohol and middle versus high income groups, were at odds with expectations and existing evidence. While some studies report health benefits associated with lower levels of alcohol consumption (57), from the available data we cannot determine whether there are unmeasured but related characteristics for which these are proxies. For example, individuals with middle income may feel less stress and be more satisfied with their life, and hence perceive their health as better compared to higher income groups. Furthermore, as with any cross-sectional data the possibility of reverse causality cannot be ruled out. We could not, therefore, evaluate whether those with better health consume more alcohol or whether drinking more predicts better self-perceived health.

There were sex differences in self-rated health and circumstances associated with it, with women rating their health more highly than men, overall. Bivariate analysis showed that women were 7 percent less likely to report poor SRH although this protective effect was only marginally significant (PRR = 0.93; 95%CI: 0.87, 1.00). The protective effect of ‘female sex’ increased dramatically to 43% (PRR = 0.57; 95%CI: 0.51, 0.64) after adjustment for a variety of confounders using the carefully specified model. This suggests that actual (as estimated in the adjusted models) good health perception is much higher in women; however, when the effects of social factors and health behaviours are not taken into account (unadjusted model) most of the effect of sex disappears. In other words, the sex-SRH relationship is strongly influenced by social and behavioral factors. Put another way, it appears to be gender rather than sex that is a strong predictor of SRH. This nuance would not have been apparent if the impact of sex, alone, been considered.

Education, vision, number of chronic conditions, and being overweight were either uniquely or more importantly associated with poor SRH for women than men. Among men, low income, being underweight and needing formal or informal care were the unique or more important characteristics underlying poorer SRH. The differential effect of body weight in men and women may speak to underlying gender stereotypes about weight. While among women in the CLSA sample being overweight was perceived stereotypically and incorrectly as unhealthy, in men the reverse occurred with underweight status perhaps being interpreted as a marker of frailty and lack of masculinity and, hence, aligning with lower
perceptions of health. Education is universally reported as a determinant of health (58), however in our study it was only a significant predictor of SRH among women. We observed that other factors such as wealth and income may have acted as proxies for education in men but not in women suggesting, once again, the gendered nature of health impacts of these social factors.

On their own, sex differences accounted for very little of the observed variability in SRH, while wealth had strong explanatory value. Clusters defined by sex and wealth explained less variability than did wealth, alone, hinting at a relationship between sex and wealth beyond an additive, interactive effect. While belonging to different wealth groups explained a large amount of the variation in SRH, when groupings were further divided to include combinations of sex and wealth that explanatory power decreased. We interpret this as evidence of an intersection rather than an interaction between the two categories. The observed, intertwined effect of sex and wealth speaks to the need for and merit of an intersectional approach to analyses. Somehow when the characteristics of sex and wealth defined clusters the impact on SRH was less than that of wealth, alone, a result that would not have been apparent had analyses considered sex or wealth as independent variables, or interactions between the two. From our research we cannot determine why sex mutes the impact of wealth on health but since we tested for an interaction between these two and that interaction was not statistically significant, we argue that there is a complex interplay between these factors, that is intersectional rather than an interactive.

We also examined intersections of sex and two additional social locations, education and place of residence. Place, defined as rural/urban status, by itself had a very small cluster effect (0.02%) but when combined with sex and education the cluster effect increased significantly such that more than 13 percent of variability in SRH was explained by differences between strata defined by intersections of sex, education, and place. This also suggests that these social identity factors concurrently impact health in an interconnected way rather than via simple additive or multiplicative interaction effects.

**Strengths and limitations**

A key strength of this study is its robust theoretical framework that looks beyond simple risk factor epidemiologic thinking. By utilizing determinants of health and intersectionality theories we have provided evidence that assists in disentangling the complexity underlying self-perceived health in old age. Use of a large, representative and national dataset of 45 + year old Canadians is another strength of the study. Large sample sizes allowed us to examine a number of interactions without diminishing statistical power.

Use of cross-sectional data inherently raises the possibility of reverse causality; we cannot assess whether social adversities preceded poor SRH. The main limitation of the research arises, however, from uncertainty about best methods for evaluating intersectionality. Several methods are suggested for such work (56) however whether any of these is 'best' is still debated (59). We selected MLA because quantification of cluster effects of social strata provides information beyond that obtainable from regular regression analyses and clearly addresses both within and across category (or cluster) variability. At
present, there is exploration and debate about best methods to study the relatively novel construct of intersectionality in quantitative health outcomes research.

5. Conclusions

After accounting for true confounders, Canadian middle-aged and older women's perceptions of their health were significantly better than were men's. In the CLSA population studied, variations in SRH are, however, better explained by considering intersections among sex, wealth, and rural/urban status.

Abbreviations

ADL: Activities of daily living
CLSA: Canadian Longitudinal Study on Aging ()
SES: Socio-economic status
SRH: Self-rated health
ICC: Intra-class Correlation Coefficients
MOR: Median Odds Ratio

Declarations

Ethics approval and consent to participate: The study was approved by the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board (HSREB). Tools for Research at Queen's (TRAQ) number: 6020994. All methods were performed in accordance with the relevant guidelines and regulations. Informed consent was obtained from all study participants.

Consent for publication: Not applicable

Availability of data and materials: The data that support the findings of this study are available from the Canadian Longitudinal Study on Aging (CLSA) but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of the Canadian Longitudinal Study on Aging (CLSA).

Competing interests: The authors declare that they have no competing interests

Funding: One of the authors (AV) was supported by The Canadian Institutes of Health Research, award number 161787.
Authors' contributions: Vafaei A: Writing - review & editing, Writing - original draft, Methodology, Data analysis, Conceptualization. Yu J: Writing - original draft, Methodology, Initial data analysis, Conceptualization. Phillips SP: Writing - review & editing, Writing - original draft, Methodology, Formal analysis, Data curation, Conceptualization. All the authors have read and approved the final version of the manuscript.

Acknowledgements: This research was made possible using the data/biospecimens collected by the Canadian Longitudinal Study on Aging (CLSA). Funding for the Canadian Longitudinal Study on Aging (CLSA) is provided by the Government of Canada through the Canadian Institutes of Health Research (CIHR) under grant reference: LSA 94473 and the Canada Foundation for Innovation. This research has been conducted using the CLSA Baseline Comprehensive Dataset version 4.0, under Application Number 170309. The CLSA is led by Drs. Parminder Raina, Christina Wolfson and Susan Kirkland.

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