Introduction

Women experience lower mortality, but report more disability compared to men of the same age. The female longevity advantage and the ‘health-survival paradox’ have received much attention in the scientific literature, but the fact that this implies that women live many more years with disability has received scant attention.\(^1\) In general, the focus of past research has been on total life expectancy and on healthy life expectancy, in Europe measured with healthy life years (HLYs).\(^2\) Gender differences in HLY are generally much smaller than in life expectancy owing to opposite gender differentials in mortality and disability, which reduce the gap in HLY. In some countries, women have fewer HLYs than men indicating that their mortality advantage is offset by their disability disadvantage. However, the same opposing gender differences increase the gender gap in unhealthy life years (ULYs).\(^3\) Gender differences in ULY may even be larger than gender differences in life expectancy.\(^1\)

Insight into the gender gap in ULY and the role of differences in mortality and disability, both in general and from specific chronic conditions, is relevant to better understand gender disparities and to optimize strategies to reduce these inequalities. A high contribution of a specific disease may point to specific risk factors, possibly modifiable.

The aim of this study is to improve understanding of gender disparities in ULY by quantifying the contribution of mortality and disability differences to the origin of gender gap in ULYs, both in total and from different causes of death and disability. We will address the following questions: (i) what is the contribution of women’s lower mortality (extending the time at risk of disability) and higher prevalence of disability to the gender gap in ULY and (ii) which causes of death and disability contribute most to this gender difference. We focus on France, given the availability of a large survey that comprises both the household and institutional population and includes a large set of conditions, including several mental disorders lacking in most previous studies.

Methods

Data

Table 1 presents the proportional mortality and disability for each disease group.

Deaths and population by age and gender for the year 2008 for France from Eurostat were derived from the Eurohex website.\(^7\)
Mortality and disability data by cause are presented in table 1. Mortality data by underlying cause of death were obtained from the CépiDc-INSERM-database.\(^8\)

Data on disability by cause were derived in a previous paper\(^9\) based on the French Disability Health Survey ('Enquête Handicap et Santé’) 2008–09 which consists of a survey among persons living in private households, HSM and a survey among persons living in nursing homes, homes for the elderly and mental institutions. Further details of the Disability Health Survey 2008–09 can be found elsewhere.\(^10,11\) Disability prevalence by cause was derived using the at-

### Definition of disability

To define disability we used the Global Activity Limitation Indicator (GALI), which is used to calculate HLY across Europe for health monitoring and target setting.\(^5,13\) The GALI is a single question ‘For at least the last 6 months, have you been limited because of a health problem in activities people usually do?’ aiming to capture long-term limitation (>6 months), and with three severity levels: none, limited but not severely and severely limited. The reliability and validity of the GALI have already been reported.\(^14–19\) People were considered to be disabled (unhealthy) when they reported any limitation. This is the cut-off used in the HLY measure in Europe.

### Causes of death

We grouped causes of death similarly to the standard groupings for causes of death, however because not all diseases that are disabling are fatal (and vice-versa) we made some adjustments. For completeness we included causes of death that do not cause long-term disability or were not distinguished in the disability survey, such as acute respiratory infections and other circulatory diseases. Causes of disability that are not common causes of death, such as musculoskeletal disorders, are included in the cause of death classification, but with virtually absent mortality.

### Life table and decomposition methods

Life expectancy with GALI disability, i.e. ULYs at age 50 for men and women were estimated by the Sullivan method. This method uses the gender-specific prevalence of disability in each age group to divide the number of person-years years in the standard life table into years with and without disability.\(^16,22\)

The contribution of specific conditions to gender difference in ULYs was estimated by a life table decomposition tool which partitions the difference in ULYs into additive contributions of causes.\(^1\) The decomposition analysis assessed the difference in ULY because of smaller (higher) total mortality rates and/or disability prevalence (by age) from a given cause, in women relative to men. First, the difference in the number of unhealthy person-years (by age) was decomposed into years with and without disability.\(^16,22\)

The contribution of specific conditions to gender difference in ULYs was estimated by a life table decomposition tool which partitions the difference in ULYs into additive contributions of causes.\(^1\) The decomposition analysis assessed the difference in ULY because of smaller (higher) total mortality rates and/or disability prevalence (by age) from a given cause, in women relative to men. First, the difference in the number of unhealthy person-years (by age) was decomposed into years with and without disability.\(^16,22\)
Contribution of mortality and disability differences

Difference

Women 19.0 (18.4 to 19.6)
Men 14.2 (13.6 to 14.8)

Cardiovascular diseases

Further decomposition of the mortality effect and disability effect of ULY by cause is presented in table 3. Of the total mortality effect of 4.0 ULYs, 1.8 ULYs were due to women’s lower mortality from cancer, 0.8 ULY from heart disease and 0.3 ULY from accidents. Table 3 also shows gender differences in the disability effects of different diseases. Higher disability from musculoskeletal diseases and anxiety-depression for women than men increased the gender gap in ULY by 1.8 and 0.6 ULY, respectively. The gender gap in ULY was reduced due to lower disability in women from: heart disease by 0.8 ULY, CNSLD by 0.4 ULY and accidents by 0.3 ULY. The sum of the mortality and disability effects showed that musculoskeletal diseases (due to their higher contribution of disability in women) and cancer (due to their lower contribution of mortality in women) had the greatest contribution to the longer ULY in women.

Results

Life expectancy of women aged 50 was 36.3 (95% CI 36.3–36.4) years and of men 30.4 years (95% CI 30.4–30.4) (table 2). Life expectancy with GALI disability was 19.0 years (95% CI: 18.4–19.6) for women compared to 14.2 years (95% CI 13.6–14.8) for men. The gender gap in total life expectancy was 5.9 years (95% CI 5.9–6.0) of which 4.8 (95% CI 4.0–5.7) were ULY.

Table 2 also shows the contribution of mortality differences (‘mortality effect’) and disability differences (‘disability effect’) to the gender difference in ULY. The lower mortality and higher disability effect increased ULY in women relative to men. The contribution of disability was 4.0 years and the disability effect was 0.8 year.

Table 2  Gender difference in ULYs at age 50, and the contribution of mortality and disability differences for men and women, France, 2008

|                      | ULY Years, (95% CI) |
|----------------------|---------------------|
| Men                  | 14.2 (13.6 to 14.8) |
| Women                | 19.0 (18.4 to 19.6) |
| Difference           |                     |
| Women—men            | 4.8 (4.0 to 5.7)    |
| Contribution of mortality and disability differences | |
| Mortality effect     | 4.0 (3.9 to 4.2)    |
| Disability effect    | 0.8 (–0.1 to 1.7)   |

Table 3  Decomposition of gender differences (women—men) in life expectancy with disability (ULY) at age 50, into mortality and disability effects and total effect by cause, France 2008

| Cause                              | Mortality effect (95% CI) | Disability effect (95% CI) | Total effect (95% CI) |
|------------------------------------|---------------------------|---------------------------|-----------------------|
| Cardiovascular diseases             |                           |                           |                       |
| Heart disease                       | 0.76 (0.75 to 0.77)       | –0.82 (–1.37 to –0.27)    | –0.06 (–0.60 to 0.49) |
| CVA                                | 0.13 (0.13 to 0.14)       | –0.23 (–0.45 to 0.00)     | –0.10 (–0.31 to 0.13) |
| PVD                                | 0.03 (0.03 to 0.03)       | –0.26 (–0.48 to –0.07)    | –0.23 (–0.44 to –0.03) |
| Other cardiovascular diseases       | 0.10 (0.10 to 0.10)       |                           |                       |
| Musculoskeletal diseases            | 0.00 (0.00 to 0.00)       | 1.84 (0.96 to 2.94)       | 1.84 (0.96 to 2.94)   |
| Cancer                             | 1.75 (1.74 to 1.77)       | 0.09 (–0.23 to 0.43)      | 1.84 (1.54 to 2.18)   |
| Neurological diseases               |                           |                           |                       |
| Alzheimer/Parkinson                 | 0.04 (0.04 to 0.04)       | 0.08 (–0.17 to 0.28)      | 0.12 (–0.14 to 0.32)  |
| Other neurological diseases         | 0.05 (0.04 to 0.05)       | –0.04 (–0.22 to 0.12)     | 0.00 (–0.17 to 0.17)  |
| Respiratory diseases                |                           |                           |                       |
| CNSLD                              | 0.14 (0.14 to 0.14)       | –0.41 (–0.84 to 0.03)     | –0.27 (–0.70 to 0.17) |
| Acute respiratory infections        | 0.10 (0.09 to 0.10)       | n.a                       | 0.10 (0.09 to 0.10)   |
| Mental diseases                     |                           |                           |                       |
| Anxiety and depression              | 0.00 (0.00 to 0.00)       | 0.63 (0.20 to 1.04)       | 0.63 (0.20 to 1.04)   |
| Other mental diseases               | 0.06 (0.06 to 0.07)       | –0.07 (–0.22 to 0.03)     | –0.01 (–0.01 to –0.02) |
| Diabetes mellitus                   | 0.08 (0.07 to 0.08)       | 0.22 (–0.15 to 0.59)      | 0.30 (–0.07 to 0.66)  |
| Accidents                           | 0.28 (0.27 to 0.28)       | –0.32 (–0.63 to –0.02)    | –0.05 (–0.35 to 0.26) |
| Other/background                    | 0.50 (0.48 to 0.51)       | 0.08 (–0.27 to 0.33)      | 0.58 (0.22 to 0.83)   |
| Total                              | 4.0 (3.9 to 4.2)          | 0.8 (–0.1 to 1.7)         | 4.8 (4.0 to 5.7)      |

Note: CVA = cerebrovascular accident (corresponding to cerebrovascular diseases according to the ICD-10 terminology). PVD = periphery vascular diseases. CNSLD = chronic non-specific lung disease. n.a = not available, no separate cause of long-term disability. Gender differences in ULY can originate from higher disability and/or from lower mortality from the condition (extending the time at risk of disability from any cause). The cause-specific mortality effects indicate the origin of the female excess in overall ULY resulting from lower female mortality, although these diseases are not the causes of the ULY themselves. The total effect refers to the disease-specific origin of the gender differences in ULY, either by higher (lower) disability from this condition, of by lower mortality from this condition, extending the time at risk of disability from any conditions.

Discussion

Summary of findings

In our study, French women spend 4.8 more years with disability than men, mainly because women live longer and are exposed to disability in these additional years. This survival advantage in women reflects their lower mortality from cancer and cardiovascular diseases, and to a smaller extent accidents and respiratory diseases, which together explained nearly 75% of women’s excess ULY. In addition, a small disability effect, reflecting higher prevalence of disability in women, contributed to <1 ULY in women. This disability effect results from the opposing contributions of specific conditions: musculoskeletal diseases and anxiety-depression contributed more to disability in women than men; and cardiovascular diseases, CNSLD and accidents contributed more to disability in men.

Strengths and weaknesses

The strength of our study includes considering disparities in both disability and mortality and using a very comprehensive and large...
Women’s excess unhealthy life years

917

Our study shows that diseases have a different impact on gender differences in ULY, depending on whether the disease is mainly life-threatening (such as cancer), mainly disabling (such as musculoskeletal) or both (such as heart diseases). A life-threatening disease reduces ULY as people live shorter lives and therefore are less exposed to disability from any cause. A disabling disease increases ULY as persons experience disability from this disease. Whether a disease which is both life-threatening and disabling reduces or increases ULY depends on the relative size of both effects.

An implication of our findings for the strategy to reduce the gender gap in ULY is that the largest reduction in the female disadvantage in ULY could be obtained by reducing male mortality disadvantage. However, this would not reduce ULY in women and would increase ULY in men in the total population. Instead, there is a strong need to target prevention of diseases that cause disability,
including musculoskeletal diseases which contribute most to disability in both men and women. This includes policies and interventions that reduce obesity by targeting sedentary behavior, physical inactivity and unhealthy diets. Moreover, reducing the disabling consequences of diseases is increasingly important, as people live longer with diseases that cause disability. Better disease management, more use of assistive devices and technological developments and adaptation of the environment are examples to reduce the burden of disability in people with diseases. This may not only reduce the gender gap in life expectancy with disability, but at the same time avoid future increases in disability for both genders.

Supplementary data
Supplementary data are available at EURPUB online.

Funding
This work was funded by the Caisse Nationale de Solidarité de Autonomie (CNSA). This research was also part of the European Joint-Action on European Health and Life Expectancy Information System (JA-EHLEIS), funded by the Executive Agency for Health and Consumer of the European Commission (agreement number 2010 23 01). The research finally benefitted from cross collaborations with the research program ISHEF (IRESP) [n° AAP-2011-01].

Conflicts of interest: None declared.

Key points
- French women’s disadvantage in ULYs compared to men is predominantly due to women’s lower mortality from cancer, cardiovascular and respiratory diseases and accidents.
- Women’s higher disability contributes moderately to their excess ULYs.
- The substantial disabling effect of musculoskeletal diseases in women’s ULY is offset by the lower contribution of heart and respiratory diseases, and accidents compared to men.

References
1. Nusselder WJ, Looman CW. Decomposition of differences in health expectancy by cause. Demography 2004;41:315–34.
2. Nusselder WJ, Looman CW, Van Oyen H, et al. Gender differences in health of EU10 and EU15 populations: the double burden of EU10 men. Eur J Ageing 2010;7:219–27.
3. Van Oyen H, Nusselder W, Jagger C, et al. Gender differences in healthy life years within the EU: an exploration of the “health-survival” paradox. Int J Public Health 2013;58:143–55.
4. Luy M, Minagawa Y. Gender gaps - Life expectancy and proportion of life in poor health. Health Rep 2014;25:12–19.
5. Jagger C, McKee M, Christensen K, et al. Mind the gap–-reaching the European target of a 2-year increase in healthy life years in the next decade. Eur J Public Health 2011;21:829–33.
6. Yokota RTC, Nusselder WJ, Robine JM, et al. Contribution of chronic conditions to gender disparities in health expectancies in Belgium, 2001, 2004 and 2008. Eur J Public Health 2018;29:82–7.
7. Eurohex. Advanced Research on Health Expectancies. Eurohex. 2016. Available at: http://www.eurohex.eu/ (18 December 2017, date last accessed).
8. Mesle F. CépiDc-INSERM Database. CépiDc-INSERM, 2008. Available at: https://www.cepидc.inserm.fr/.
9. Nusselder WJ, Wappeler D, Looman CWN, et al. Contribution of chronic conditions to disability in men and women in France. Eur J Public Health 2018;29:99–104.
10. INSEE, Enquête Handicap-santé - Volet Institutions 2009/HS1. INSEE. 2016. Available at: https://www.insee.fr/fr/metadonnees/source/s1244 (28 April 2016, date last accessed).
11. INSEE, Enquête Handicap-santé 2008 - Volet Ménages/HSM. INSEE. 2016. Available at: https://www.insee.fr/fr/metadonnees/source/s1245 (25 March 2016, date last accessed).
12. Yokota RTC, Van Oyen H, Looman CWN, et al. Multinomial additive hazard model to assess the disability burden using cross-sectional data. Biom J 2017;59:901–17.
13. Lagiewka K. European innovation partnership on active and healthy ageing: triggers of setting the headline target of 2 additional healthy life years at birth at EU average by 2020. Arch Public Health 2012;70:23
14. Cox B, van Oyen H, Cambois E, et al. The reliability of the Minimum European Health Module. Int J Public Health 2008;54:55–60.
15. Van Oyen H, Van der Heyden J, Perenboom R, Jagger C. Monitoring population disability: evaluation of a new Global Activity Limitation Indicator (GALI). Soz Praventivmed 2006;51:153–61.
16. Jagger C, Gilles C, Cambois E, et al. The Global Activity Limitation Index measured function and disability similarly across European countries. J Clin Epidemiol 2010;63:892–9.
17. Van der Heyden J, Berger N, Van Oyen H. Comparison of self-rated health and activity limitation as predictors of short term mortality in the older population. Public Health 2015;129:283–5.
18. Berger N, Van Oyen H, Cambois E, et al. Assessing the validity of the Global Activity Limitation Indicator in fourteen European countries. BMC Med Res Methodol 2015;15:1.
19. Van Oyen H, Boogaert P, Yokota RTC, Berger N. Measuring disability: a systematic review of the validity and reliability of the Global Activity Limitations Indicator (GALI), Arch Public Health 2018;76:25.
20. Nusselder WJ, Looman CW, Mackenbach JP, et al. The contribution of specific diseases to educational disparities in disability-free life expectancy. Am J Public Health 2005;95:2035–41.
21. Klis B, Nusselder WJ, Looman CW, Mackenbach JP. Contribution of chronic disease to the burden of disability. PLoS One 2011;6:e25325.
22. Jagger C, Van Oyen H, Robine JM. Health Expectancy Calculations by the Sullivan Method: a Practical Guide. 2014.
23. Andreev E, Shkolnikov V, Begun A. Algorithm for decomposition of differences between aggregate demographic measures and its application to life expectancies, healthy life expectancies, parity progression ratios and total fertility rates. Demogr Res 2002;7:499–522.
24. Oksanen T, Kivimaki M, Pentti J, et al. Self-report as an indicator of incident disease. Ann Epidemiol 2010;20:547–54.
25. Crimmins EM, Kim JK, Sole-Auro A. Gender differences in health: results from SHARE, ELSA and HRS. Eur J Public Health 2011;21:81–91.
26. Kriegman DM, Penninx BW, van Eijk JT, et al. Self-reports and general practitioner information on the presence of chronic diseases in community dwelling elderly. A study on the accuracy of patients’ self-reports and on determinants of inaccuracy. J Clin Epidemiol 1996;49:1407–10.
27. Case A, Paxson C. Sex differences in morbidity and mortality. Demography 2005;42:189–214.
28. Merrill SS, Seeman TE, Karl SV, Berkman LF. Gender differences in the comparison of self-reported disability and performance measures. J Gerontol A Biol Sci Med Sci 1997;52:M19–26.
29. Okuzuyan A, Guma J. Sex differences in health and survival. In: Guma J, editor. A Demographic Perspective on Gender, Family and Health in Europe. Cham, Switzerland: Springer, 2018:65–100.
30. Whiteford HA, Degenhardt L, Rehm J, et al. Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010. Lancet 2013;382:1575–86.
31. Imai K, Soneji S. On the estimation of disability-free life expectancy: Sullivan’s method and its extension. J Am Stat Assoc 2007;102:199–211.
32. Barendregt JJ, Bonneux L, Van der Maas PJ. Health expectancy: an indicator for change? Technology Assessment Methods Project Team. J Epidemiol Community Health 1994;48:482–7.
33. Van de Water HP, Boshuizen HC, Perenboom R, et al. Health expectancy: an indicator for change? J Epidemiol Community Health 1995;49:330–1.
34. Mathers CD, Robine JM. How good is Sullivan’s method for monitoring changes in population health expectancies? J Epidemiol Community Health 1997;51:980–6.
35. Hohn A, Larsen LA, Schneider DC, et al. Sex differences in the 1-year risk of dying following all-cause and cause-specific hospital admission after age 50 in comparison with a general and non-hospitalized population: a register-based cohort study of the Danish population. BMJ Open 2018;8:e021813
Introduction

Adolescent health, and disparities in health status, track forward to adulthood. Although adolescence is seen as a critical period in many global health agendas, the health of adolescents has received less attention than that of other age groups. In research on disparities, the concept of health literacy (HL) as a set of competencies (e.g. critical thinking, self-awareness and citizenship) to promote and sustain health may help in understanding the disparities better, and in deciding the factors that can be influenced. As HL is something that can be developed and learned, it may be a crucial factor in addressing avoidable and unfair health disparities. However, not much is known about precisely how HL is related to health disparities, or whether the association already exists among adolescents.

Health disparities are caused by many factors, some of which consist of structural stratifiers, with their proxy indicators such as income, access to education, social class, gender, ethnicity and employment opportunities. According to Galobardes et al. the stratifiers determine ‘which resources and goods are distributed to and accumulated over time by different social groups’ (p. 21), and inequality in the distribution causes health differences.

The latest report of the international Health Behaviour in School-aged Children (HBSC) study confirms that many of the structural stratifiers examined among adults are relevant to health disparities among young people, but they have not received that much attention. According to the report, poorer health outcomes are more prevalent among older children and among children from less affluent families. As the children become older, they are less physically active, they drink and smoke more, and perceive their health as worse than that of younger children. Children from less affluent families consistently perceive their health as poorer. They brush their teeth less often, and eat fewer vegetables and fruits. The health differences explained by inequalities in socioeconomic status have increased during the 21st century. However, gender comparisons show that while girls report lower health and life-satisfaction, more health complaint, and less physical activity, they brush their teeth more often, drink less alcohol, smoke less and eat more fruit and vegetables than boys. These findings confirm the argument of Braveman et al. that ‘although health disparities are systematic, a socially disadvantaged group will not necessarily fare worse on all health indicators, and might fare better on some' (p. s152).