Trends in Disability-Free Life Expectancy (DFLE) from 1995 to 2017 in the older Norwegian population by sex and education: The HUNT Study

Siri H Storeng[1,2], Simon Øverland[3,4], Vegard Skirbekk[3], Laila Arnesdatter Hopstock[5], Erik R Sund[6,7,8], Steinar Krokstad[6,8], Bjørn Heine Strand[2,9,10]

1. Department of Public Health and Nursing, Faculty of Medicine and Health Sciences, NTNU – Norwegian University of Science and Technology, Trondheim, Norway
2. Department of Chronic Diseases and Ageing, Norwegian Institute of Public Health, Norway
3. Center for Disease Burden, Norwegian Institute of Public Health, Norway
4. Department of Psychosocial Science, Faculty of Pscyhology, University of Bergen, Norway
5. Department of Community Medicine, Faculty of Health Sciences, UiT The Arctic University of Norway, Tromsø, Norway
6. HUNT Research Centre, Department of Public Helath and Nursing, Faculty of Medicine and Health Sciences, Norwegian University of Science and Technology, NTNU, Levanger, Norway
7. Faculty of Nursing and Health Sciences, Nord University, Levanger, Norway
8. Levanger Hospital, Nord-Trøndelag Hospital Trust, Norway
9. Norwegian National Advisory Unit on Ageing and Health, Vestfold Hospital Trust, Tønsberg, Norway
10. Department of Geriatric Medicine, Oslo University Hospital, Oslo, Norway

Corresponding autor

Siri H. Storeng

Department of Public Health and Nursing, Faculty of Medicine and Health Sciences

Norwegian University of Science and Technology, NTNU

Post box 8905, Håkon Jarls gate 11, N-7491 Trondheim, Norway

Email: siri.h.storeng@ntnu.no

Phone: +47 91750425

Abstract

Aim: Understanding whether increasing life expectancy (LE) translates to improved health and function among older adults is essential, but results are inconclusive. We aimed to estimate trends in Disabiltiy-Free Life Expectancy (DFLE) in the older Norwegian population by sex and education from 1995 to 2017.

Method: National life table data were combined with cross-sectional data on functional ability for 70+ year olds from the population-based Trøndelag Health Surveys 2-4 (1995-97, 2006-08 and 2017-19) (n=24,733). Self-reported functional ability was assessed on a graded scale by a combination of Instrumental Activities of Daily Living (IADL) such as paying bills, going out, or shopping (mild disability) and Personal Activities of Daily Living (PADL) such as washing, dressing or eating (severe disability). LE, DFLE, Mild-Disabilty LE, and Severe-Disability LE at age 70 were estimated by the Sullivan method.

Results: From 1995-2017 DFLE at age 70 increased from 8.5 to 13.0 years in women, and from 8.0 to 12.1 years in men. DFLE increased in all educational groups, but more in the higher educational groups (1.2 and 1.1 extra years for men and women). The educational gap in DFLE increased for both women (1.6-2.7 years) and men (1.3-2.5 years), but inequalities in years spent with disability decreased or remained stable.

Conclusions: From the mid-1990ies and over the past three decades both LE and DFLE at 70 years increased in the older Norwegian population, for both men and women, and across basic and high educational levels. Educational inequalities in DFLE increased, but years spent with disability were similar.

Key words: Disability-Free Life Expectancy, Activities of Daily Living, Life Expectancy, Aged, Norway, HUNT

Word count: 2958

Background

Life expectancy (LE) and the number of older adults are increasing worldwide.[1] In Norway, LE at birth (LE_0) increased from 75 to 81 years in men and 81 to 84 in women during 1995-2019.[2] During the same period, LE at 70 years (LE_{70}) increased by four years in men and three years in women.[2] When LE increases, the proportion of life spent with disability may be compressed, expanded or stable.[1] However, at present there is limited evidence on recent trends in disability among older Norwegians, and we cannot conclude which of these three scenarios has occurred. This would be relevant knowledge for planning of future resource allocation, health care services and pensioning age.

The World Health Organization (WHO) has stressed the need to study functional ability, rather than just the prevalence of diseases or comorbidities.[3] Functional ability is the interaction between an individual's intrinsic capacity and the environmental demands.[3] Disability may be used as a measure of functional ability, and defined as "difficulty doing activities in any domain of life [..] due to a health or physical problem."[4] Women and lower educated groups have been found at higher risk of developing diabilities compared with men and higher educated groups.[1] Increasing inequalities in LE between socioeconomic status (SES) groups have been found in Norway,[5] and it is of intrerest whether this also applies to disability-free life exepctancy (DFLE).

Health expectancy calculations combine mortality and morbidity data to provide a composite measure of the health status in a population. One such measure, DFLE, is an estimate of years expected to be lived without disability. A common measure of disability is Activities of Daily Living (ADL).[6] Personal ADL (PADL) include abilities necessary for basic functioning such as bathing, dressing, or eating,[7] while Instrumental ADL (IADL) assess somewhat higher levels of performance, such as the ability to pay bills, go out, or do shopping.[8] There is limited data on DFLE in Norway, and this is the first study including data from the last decade.

Aim

The aim of this study was to estimate time trends in DFLE and years lived in disability from 1995 to 2017 in older Norwegians by sex and education.

Methods

Study population

The study population was a combination of aggregated data from two data sources for Norwegian adults aged 70 years or older: 1) national life table registry data on mortality and population size by sex, education and year; and 2) self-reported disability data from the Nord-Trøndelag Health Surveys (HUNT) 2, 3 and 4 by sex, education and year. In lack of national disability data of current date, the HUNT Surveys were used as proxy for nationally representative data on community-dwelling older adults.

Registry data

National data on mortality for the years close to the initial years for the HUNT Surveys (1995, 2006 and 2016 – latest year available) was provided by *microdata.no*. Microdata is a collaboration service by the Norwegian Centre for Recearh Data (NSD) and Statistics Norway (SSB). The population aged 70 years and older and alive at January 1st was followed up for one year by sex and education, and mortality was registered. This included 34,057 deaths among 497,679 individuals (mid-year population) in 1995, 31,703 deaths among 491,878 individuals in 2006 and 30,822 deaths among 576,537 individuals in 2016. Education from the National education database (NUDB) was assessed at January 1st and grouped as basic (9 years or less, ISCED 2011 level 1-2) or higher (10+ years, ISCED 2011 level 3-8). Only two levels were used due to low numbers in the higher educational levels.

HUNT Survey data

In total, 24,733 participants aged 70 years and older, who completed the ADL questions in HUNT2 in 1995-97 (n=8,895), HUNT3 in 2006-08 (n=6,652) and HUNT4 in 2017-2019 (n=9,186) were included (Appendix table 1). The HUNT Study is a mix of cross sectional and

longitudinal study as all are invited. Our purpose was to compare cross sectionally different birth cohorts at the same age at different time points, but some participants are included more than once (84% participated once, 15% twice and 1% three times). The HUNT Study was conducted in Nord-Trøndelag County which includes both rural and urban populations, and has been found to be fairly representative of the Norwegian population.[9]

Activities of Daily Living (ADL)

Activities of Daily Living (ADL) are self-reported questions concerning practical everyday tasks.[10] ADL can be characterized as Personal ADL (PADL) covering basic tasks, and Instrumental ADL (IADL) covering slightly higher levels of performance. ADL items included in the HUNT Study are shown in Appendix table 2. To avoid gender bias, the three IADL items *prepare warm meals, do light housework* and *do laundry* were removed from the analyses.[11] There were three response categories (1=yes; 2=with some help; 3=no) in HUNT2, and two (1=yes; 2=no) in HUNT3 and HUNT4. In line with previous reports,[12] the latter two categories were combined in HUNT2. Responses were dichotomized into PADL disability if they answered yes on at least one of the PADL items, and no PADL disability if they answered no for all items (see Appendix table 2). To be included in the study the respondent had to answer at least one of the items in the PADL battery. In a sensitivity analysis a stricter inclusion criterium were applied, including only those with non-missing for at least five out of seven PADL items. The two disability prevalences were similar in the two settings, and therefore the former was applied to increase sample size. A similar procedure was applied for IADL.

A graded disability construct based on PADL and IADL

A graded disability construct with three categories based on a combination of PADL and IADL was made: 1) No IADL or PADL disability (*no disability*), 2) IADL disability only (*mild* disability) and 2) PADL disability only or in combination with IADL disability (*severe* disability).[13] This graded disability variable was used in the $LE_{(70)}$ calculations which was decomposed into three groups: DFLE, Mild-Disabilty LE, and Severe-Disability LE, with accompanying 95% confidence intervals.

Education

Education in HUNT was self-reported. In HUNT3, education was only registered for a small subsample (6%), and therefore education in HUNT3 was imputed from HUNT2 (91%). A small fraction was also imputed from HUNT4 (3%). Overall, missing values for education were 3%, 3% and 1%, for HUNT2, HUNT3, and HUNT4, respectively. Education at all three surveys were dichotomised to match the coding used in the registry data as basic (≤9 years) or higher (10+ years).

Statistical methods

First, prevalences of each of the three states of the graded disability construct were predicted from a general linear model with poisson distribution and identity link, including the covariates age (aggregated in 5-year age intervals), sex and a dummy variable indicating the HUNT Survey (2, 3 or 4). All interactions (three-way and two-way) were included to ensure full flexibility in the modelling and allowing trends to differ by sex and age. Separate models were run for the educational groups. Secondly, national mortality rates were calculated for one-year age bands from age 70 to 87+ for 1995 and 2006, and 70 to 88+ years for 2016, and smoothed using Poisson regression and splines. Due to legal data restrictions in microdata.no, those older than 87 years for HUNT2 and HUNT3, and 88 years for HUNT4 were collapsed

into one group and denoted 87+ and 88+ years, respectively. Thirdly, life tables and LEs were calculated based on mortality rates and number of persons from national registry data. Lastly, based on prevalences from the HUNT Surveys years spent in each of the three disabilty categories, with accompanying 95% confidence intervals, were calculated according to the Sullivan method[14].

Comparability across HUNT Surveys

The population size in the former county of Nord-Trøndelag has been stable since the first HUNT Survey in 1984 with little in- and out migration.[15] The response rate for those aged 70 years and older with valid data on ADL and education was 61% in HUNT2, 49% in HUNT3, and 47% in HUNT4 (Appendix table 1). Data in the HUNT Surveys were collected in a similar manner at field stations. In HUNT4 an additional data collection from home visits and nursing homes was prioritized to increase participation in these groups and to get a more representative sample of older adults. To ensure comparability across study waves this sample was not included in the main analyses, but an additional analysis including this sample was performed for HUNT4 to investigate how the inclusion of these groups impacted the results (Appendix figure 1).

Ethics

The Regional Committee for Medical and Health Research Ethics (REC) approved HUNT2 and HUNT3, and participants signed a written informed consent to participate. HUNT4 was licenced by the Norwegian Data Protection Authority. This study was approved by REC (REC 2019/149 South East).

Results

Table 1 goes here

Prevalence of disability

In general, self-reported disability decreased during 1995-2017, except for a slight increase in severe disability among men in the oldest age group and women in the highest educated group during 2006-2017. During 1995-2017, the percentage reporting no disability increased from 70% to 81% in men and 62% to 77% in women. Thus, disability was slighly more prevalent in women. Both mild and severe disability increased by age, and was higher among those with basic educational level compared to those with higher education. In general, mild disability was more prevalent than severe disability; 13% vs 6% in men and 16% vs 7% in women in 2017.

Table 2 and figure 1 goes here

Time trends

Between 1995 and 2017 LE increased by 3.4 years for men (from 11.9 to 15.3 years) and 2.4 years for women (from 14.7 to 17.1 years). LE increased more for those with high education compared to low education; in men with high education LE increased by 3.4 years from 12.7 to 16.1 years, while in low education LE increased by 2.6 years from 11.1 to 13.7 years. Correspondingly, in high educated women LE increased by 2.3 years from 16.2 to 18.5 years, while for low education the increase was 1.5 years from 14.0 to 11.5. There was a significant increase in DFLE for both men (4.1 years) and women (4.6 years) and both educational groups (3.1-4.7 years) between 1995-2017 (table 2, figure 1). DFLE increased the most for women and for those with high education. Except for women with basic education, years with

mild disability decreased more than years with severe disability from 1995-2017. Women with basic education had the largest reduction in years of severe disability (-1.3 years). In sum, there was both an absolute (in years) and relative (compared to LE) compression of disability between 1995-2017.

Table 3 and figure 2 goes here

Sex and educational differences

From 1995 to 2017 differences in $LE_{(70)}$ between men and women decreased from 2.8 to 1.8 years. At the same time, there were increasing educational differences in DFLE for both men and women. This was driven mainly by increasing educational differences in $LE_{(70)}$, since there were decreasing/neglible educational differences in disability (figure 2). Differences in Severe-Disability LE decreased between men and women and remained stable or neglible between educational groups over the same time period (table 3). In HUNT2 (1995-97) women could expect to live more years with Severe-Disability LE than men, but had a greater improvement over time, and differences between men and women were neglible in 2017 (table 3). Decreasing differences in Mild-Disability LE were observed between both sexes and educational groups from 1995 to 2017.

Including institutionalized in HUNT4

When including data from participants from home visits and nursing homes (n=570) in the overall sample from HUNT4, the percentage reporting low levels of disability remained relatively stable, while the percentage reporting high levels of disability increased (table 1). Consequently, DFLE in HUNT4 decreased when including this sample in the calculations.

Discussion

Key findings

In this study among older Norwegians, DFLE increased more than $LE_{(70)}$ and expected years spent with disability decreased from 1995 to 2017. There was a compression of disability for both sexes and in both educational groups. Sex differences in expected years with disability decreased in the same period, and in 2017 there were no differences in expected years with severe disability. Sex differences in DFLE first increased from 1995 to 2006 and then remained constant. Educational differences in DFLE and $LE_{(70)}$ increased from 1995 to 2017, while differences in expected years with mild disability decreased, and differences in years with severe disability remained neglible.

Trends in disability prevalence

Overall, ADL disability seems to increase stadily with age, and IADL disability is more common but less severe than ADL disability.[1] In line with results from this study, a Norwegian study based on a national sample of the non-institutionalised population aged 67 years and older found downward trends in both prevalence and life expectancy with mild disability between 1986-2008.[16] Among Swedish 75-year-olds prevalence of ADL and IADL disability decreased from 1976-2006.[17] Larger review studies report a decline in prevalence of disability over time, with simultaneous increase in chronic disease.[1, 18, 19]

Trends in DFLE

Globally, population growth and increased LE has led to a total increase in years lived with disability, even though there has been a slight decrease in age-standardised disability incidence rates.[20] DFLE is commonly assesed by using ADL or the Global Activity Limitation Index (GALI). GALI consists of a question about activitiy limiations the past six

months due to a health problem. In Sweden, years with activity limitations (based on GALI) at age 65 years decreased between 1980-2011, and there was a compression of disability.[21] In USA, increased DFLE among older adults between 1980-2010 has been found.[22] The increase for men was higher compared to women, and thus sex differences decreased.[23] Findings from review studies are in line with this study, where women and higher educated groups have been found to have higher LE and DFLE than men and lower educated groups.[1, 18, 19]

Interpretation of findings

The finding that $LE_{(70)}$ increased and years with disability was compressed between 1995-2017 may be explained by improved prevention and treatment of diseases. This may in turn have improved health and function. PADL dependency has been found to be associated with higher level of home nursing.[24] Thus, decreasing years with severe disability might indicate a lower demand for home nursing per person, but the total demand will depend on the number of older adults. Further, technological advances and societal changes may also affect functional abilities, without altering older adults' intrinsic capacity.[3] Thus, objective measurements of function in older adults should also be studied. Further research is needed to investigate the causes underlying the increase in DFLE and compression of disability.

We found that DFLE increased more among higher educated compared to the group with basic education. However, this change was mainly due to increasing inequalities in LE since expected years with severe disability was similar for those with basic and high education during the whole study period. One possible interpretation is that severe disability occurs towards the end of life, but occurs later among those with higher education as they live longer. Those with high ecucation could in fact expect to live slightly longer with mild disability. Thus, it could be that increasing $LE_{(70)}$ results in more years spent with mild

disability. The general educational level in the population has increased over the same time period, and consequently more people have moved into the high educated group. This group with basic education has become more marginalized which could have contributed to the increasing educational difference in DFLE.

Expected years spent with severe disability among men decreased, but more so for women and thereby sex differences disappeared. However, women could expect to live more years than men with mild disability, in line with findings that women experience higher rates of frailty (often including physical function) during their lives compared with men.[25] Men have been found to be less likely to do the IADL activities housekeeping and laundering, for reasons unrelated to health limitations – reflecting gendered expectations regarding household activities.[11] This is in line with our results, which indicated gender bias for some IADL items, especially cooking, doing light housework and laundry. Consequently, these items were excluded from the analysis.

Strengths and limitations

Strengths of this study are the high quality data from national registers and the population based HUNT Study with high participation. Except for a more active recruitement of older participants in HUNT4 including nursing homes and home visits, the same data collection procedure were used in all HUNT Surveys, which gives comparable data over time and the long follow-up time enables the study of trends.

Several limitations should be highlighted. First, as HUNT2 had the highest response rate, this sample might be more representative of the total underlying population, while the latter two study waves might have had a stronger healthy selection bias, biasing the findings towards

improved functioning. Nevertheless, it is unlikely that such a bias was driving the positive DFLE trend between the latter two waves because the response rate in HUNT4 was similar to HUNT3. Secondly, participation in the HUNT Study depended on attendance at a field station, but in HUNT4 additional data were collected from home visits and nursing homes. When including this sub-sample in the calculations for HUNT4, DFLE and $LE_{(70)}$ decreased, incidcating that DFLE for the whole population would be somewhat lower. Third, non-participants in HUNT3 have been found to have lower SES and higher prevalence of several chronic illnesses.[26] Thus, the findings may be generalised to the healthier part of the older Norwegian population. Lastly, data on mortality from microdata was only available until 2016, and this was applied to data from HUNT4 which was carried out in 2017-2019. Mortality data for HUNT2 (1995-97) and HUNT3 (2006-08) corresponded to the first year of the survey (1995 and 2006).

Conclusions

Findings from this study suggest a compression of disability among older Norwegians from the 1990s until recently. The educational gap in DFLE increased in both sexes, but inequalities in years spent with disability decreased or remained stable. More research is needed to investigate causes behind this trend, and evaluate the impact of population aging on future need of health-, nursing- and home care. To get a better picture of the health care load associated with population ageing, expected life years with utilisation of health care services could be calculated.

Acknowledgements

The Nord-Trøndelag Health Study (The HUNT Study) is a collaboration between HUNT Research Centre (Faculty of Medicine, Norwegian University of Science and Technology, NTNU), Nord-Trøndelag County Council, Central Norway Health Authority, and the Norwegian Institute of Public Health.

Declaration of conflicting interests

The authors declare that they have no conflicts of interests.

Funding

This work was funded by the Norwegian Directorate of Health.

Research ethics and patient consent

This study was approved by the Regional Committee for Medical and Health Research Ethics (REC 2019/149 South East). HUNT2 and HUNT3 was approved by the Regional Committee for Medical and Health Research Ethics and all participants signed a written consent to participate. HUNT4 was licenced by the Norwegian Data Protection Authority in 2017.

Data

The Nord-Trøndelag Health Study (HUNT) has invited persons aged 13-100 years to four surveys between 1994 and 2019. Comprehensive data from more than 150,000 persons having participated at least once and biological material from 100,000 persons are collected. The data are stored in HUNT databank and biological material in HUNT biobank. HUNT Research Centre has been given concession to store and handle these data by the Norwegian Data Inspectorate. The key identification in the data base is the unique personal identification

number given to all Norwegians at birth or immigration, whilst de-identified data are sent to researchers. Due to confidentiality HUNT Research Centre wants to limit storage of data outside HUNT databank, and we have restrictions for researchers for handling of HUNT data files. We have precise information on all data exported to different projects and there are no restrictions regarding data export given approval of applications to HUNT Research Centre. http://www.ntnu.edu/hunt/data

Microdata is a collaboration by Norwegian Centre for Recearh Data (NSD) and Statistics Norway (SSB). The service provides access to anonymous register data from SSB. Researchers and students at approved research institutions can be registered to gain access to the data. https://microdata.no/

References

1. Chatterji S, Byles J, Cutler D, et al. Health, functioning, and disability in older adults--present status and future implications. *Lancet* 2015; 385: 563-575. 2014/12/04. DOI: 10.1016/S0140-6736(14)61462-8.

2. Deaths, https://www.ssb.no/en/statbank/table/05375 (2019, accessed May 4th 2020).

3. World Health Organization. *World report on ageing and health*. 2015. Luxembourg: World Health Organization.

4. Verbrugge LM and Jette AM. The disablement process. *Soc Sci Med* 1994; 38: 1-14. 1994/01/01. DOI: 10.1016/0277-9536(94)90294-1.

5. Kinge JM, Modalsli JH, Overland S, et al. Association of Household Income With Life Expectancy and Cause-Specific Mortality in Norway, 2005-2015. *JAMA* 2019; 321: 1916-1925. 2019/05/15. DOI: 10.1001/jama.2019.4329.

6. Yang M, Ding X and Dong B. The measurement of disability in the elderly: a systematic review of self-reported questionnaires. *J Am Med Dir Assoc* 2014; 15: 150 e151-159. 2013/12/10. DOI: 10.1016/j.jamda.2013.10.004.

7. Katz S, Ford AB, Moskowitz RW, et al. Studies of Illness in the Aged. The Index of Adl: A Standardized Measure of Biological and Psychosocial Function. *JAMA* 1963; 185: 914-919. 1963/09/21. DOI: 10.1001/jama.1963.03060120024016.

8. Lawton MP and Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. *Gerontologist* 1969; 9: 179-186. 1969/01/01.

9. Holmen J, Midthjell K, Krüger Ø, et al. The Nord-Trøndelag Health Study 1995–97 (HUNT 2). *Norsk Epidemiologi* 2003; 13: 19-32.

10. Grov EK, Fossa SD and Dahl AA. Activity of daily living problems in older cancer survivors: a population-based controlled study. *Health Soc Care Community* 2010; 18: 396-406. 2010/05/25. DOI: 10.1111/j.1365-2524.2010.00912.x.

11. Sheehan CM and Tucker-Drob EM. Gendered Expectations Distort Male-Female Differences in Instrumental Activities of Daily Living in Later Adulthood. *J Gerontol B Psychol Sci Soc Sci* 2019; 74: 715-723. 2017/02/06. DOI: 10.1093/geronb/gbw209.

12. Aunsmo RH and Holmen J. Are elderly HUNT participants healthier than before? *Tidsskr Nor Laegeforen* 2017; 137 2017/09/20. DOI: 10.4045/tidsskr.16.0557.

13. Spector WD and Fleishman JA. Combining activities of daily living with instrumental activities of daily living to measure functional disability. *J Gerontol B Psychol Sci Soc Sci* 1998; 53: S46-57. 1998/02/20. DOI: 10.1093/geronb/53b.1.s46.

14. Jagger C. *Health Expectancy Calculation by the Sullivan Method: A Practical Guide*. 2001.

15. Krokstad S, Langhammer A, Hveem K, et al. Cohort Profile: the HUNT Study, Norway. *Int J Epidemiol* 2013; 42: 968-977. 2012/08/11. DOI: 10.1093/ije/dys095.

16. Moe JO and Hagen TP. Trends and variation in mild disability and functional limitations among older adults in Norway, 1986-2008. *Eur J Ageing* 2011; 8: 49-61. 2011/04/09. DOI: 10.1007/s10433-011-0179-3.

17. Falk H, Johansson L, Ostling S, et al. Functional disability and ability 75-year-olds: a comparison of two Swedish cohorts born 30 years apart. *Age Ageing* 2014; 43: 636-641. 2014/03/07. DOI: 10.1093/ageing/afu018.

18. Parker MG and Thorslund M. Health trends in the elderly population: getting better and getting worse. *Gerontologist* 2007; 47: 150-158. 2007/04/19. DOI: 10.1093/geront/47.2.150.

19. Christensen K, Doblhammer G, Rau R, et al. Ageing populations: the challenges ahead. *Lancet* 2009; 374: 1196-1208. 2009/10/06. DOI: 10.1016/S0140-6736(09)61460-4.

20. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis

for the Global Burden of Disease Study 2017. *Lancet* 2018; 392: 1789-1858. 2018/11/30. DOI: 10.1016/s0140-6736(18)32279-7.

21. Lagergren M, Johnell K, Schon P, et al. Healthy life years in old age: Swedish development 1980-2010 according to different health indicators. *Scand J Public Health* 2016; 44: 55-61. 2015/09/24. DOI: 10.1177/1403494815605195.

22. Crimmins EM, Zhang Y and Saito Y. Trends Over 4 Decades in Disability-Free Life Expectancy in the United States. *Am J Public Health* 2016; 106: 1287-1293. 2016/04/15. DOI: 10.2105/AJPH.2016.303120.

23. Freedman VA, Wolf DA and Spillman BC. Disability-Free Life Expectancy Over 30 Years: A Growing Female Disadvantage in the US Population. *Am J Public Health* 2016; 106: 1079-1085. 2016/03/18. DOI: 10.2105/AJPH.2016.303089.

24. Dale B, Saevareid HI, Kirkevold M, et al. Formal and informal care in relation to activities of daily living and self-perceived health among older care-dependent individuals in Norway. *Int J Older People Nurs* 2008; 3: 194-203. 2008/09/01. DOI: 10.1111/j.1748-3743.2008.00122.x.

25. Gordon EH, Peel NM, Samanta M, et al. Sex differences in frailty: A systematic review and meta-analysis. *Exp Gerontol* 2017; 89: 30-40. 2017/01/04. DOI: 10.1016/j.exger.2016.12.021.

26. Langhammer A, Krokstad S, Romundstad P, et al. The HUNT study: participation is associated with survival and depends on socioeconomic status, diseases and symptoms. *BMC Med Res Methodol* 2012; 12: 143. 2012/09/18. DOI: 10.1186/1471-2288-12-143.

Table 1. Prevalence of disability by education, sex and age group, the HUNT Study, Norway

	No disability[1]								Mild disability								Severe disability							
Age, years	1995		2006		2017		2017*		1995		2006		2017		2017*		1995		2006		2017		2017*	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Men																								
Basic education																								
70-74	822	(78)	496	(86)	542	(87)	543	(86)	192	(18)	65	(11)	65	(10)	66	(10)	36	(3)	18	(3)	17	(3)	24	(4)
75-79	654	(69)	424	(79)	417	(80)	419	(79)	213	(24)	93	(17)	79	(15)	81	(15)	64	(7)	17	(3)	23	(4)	32	(6)
80-84	279	(58)	231	(69)	214	(73)	215	(69)	161	(33)	84	(25)	69	(23)	73	(24)	41	(9)	20	(6)	11	(4)	22	(7)
85+	84	(36)	90	(60)	98	(56)	101	(43)	105	(45)	50	(34)	57	(32)	75	(32)	43	(19)	9	(6)	21	(12)	57	(24)
Total	1839	(68)	1241	(78)	1271	(79)	1278	(75)	689	(25)	292	(18)	270	(17)	295	(17)	184	(7)	64	(4)	72	(4)	135	(8)
High education																								
70-74	466	(84)	536	(92)	1197	(92)	1198	(91)	78	(14)	38	(7)	80	(6)	81	(6)	12	(2)	11	(2)	30	(2)	34	(3)
75-79	261	(75)	360	(84)	729	(90)	733	(89)	78	(22)	60	(14)	62	(8)	66	(8)	11	(3)	9	(2)	15	(2)	28	(3)
80-84	78	(55)	197	(69)	313	(77)	314	(74)	54	(38)	71	(25)	80	(20)	82	(19)	9	(6)	17	(6)	14	(3)	30	(7)
85+	27	(38)	53	(60)	119	(60)	121	(50)	29	(41)	30	(34)	65	(33)	77	(32)	15	(21)	5	(6)	16	(8)	42	(18)
Total	832	(74)	1146	(83)	2358	(87)	2366	(84)	239	(21)	199	(14)	287	(11)	306	(11)	47	(4)	42	(3)	75	(3)	134	(5)
Women																								
Low education																								
70-74	1140	(73)	724	(86)	719	(89)	722	(88)	308	(20)	103	(12)	74	(9)	75	(9)	105	(7)	14	(2)	15	(2)	24	(3)
75-79	954	(64)	682	(79)	592	(84)	595	(81)	397	(27)	157	(18)	93	(13)	105	(14)	147	(10)	20	(2)	16	(2)	32	(4)
80-84	398	(45)	404	(65)	343	(72)	346	(67)	347	(39)	183	(30)	117	(24)	129	(25)	141	(16)	31	(5)	19	(4)	40	(8)
85+	110	(29)	149	(47)	153	(49)	159	(31)	157	(41)	132	(41)	130	(41)	189	(37)	115	(30)	39	(12)	32	(10)	159	(31)
Total	2602	(60)	1959	(74)	1807	(78)	1822	(71)	1209	(28)	575	(22)	414	(18)	498	(19)	508	(12)	104	(4)	82	(4)	255	(10)
High education																								

70-74	257	(76)	405	(93)	1180	(92)	1180	(92)	73	(22)	31	(7)	87	(7)	89	(7)	8	(2)	1	(0)	13	(1)	18	(1)
75-79	163	(69)	277	(83)	658	(85)	658	(83)	58	(25)	54	(16)	101	(13)	104	(13)	14	(6)	4	(1)	14	(2)	27	(3)
80-84	61	(57)	134	(77)	274	(81)	278	(78)	31	(29)	35	(20)	51	(15)	60	(17)	15	(14)	5	(3)	12	(4)	20	(6)
85+	22	(33)	38	(45)	91	(57)	95	(41)	29	(44)	40	(48)	55	(34)	74	(32)	15	(23)	6	(7)	14	(9)	60	(26)
Total	503	(67)	854	(83)	2203	(86)	2211	(83)	191	(26)	160	(16)	294	(12)	327	(12)	52	(7)	16	(2)	53	(2)	125	(5)

[*] Including data from participants from home visits and nursing homes (n=570) in the overall sample from HUNT4

[1] No disability = no IADL or PADL disability, Mild disability = IADL disability only, and Severe disability = PADL disability only or in combination with IADL disability

[2] Education was split into basic (9 years or less, ISCED 2011 level 1-2) and higher education (10+ years, ISCED 2011 level 3-8)

Table 2. Life Expectancy (LE), Disability-Free LE (DFLE), Mild-Disability LE, Severe-Disability LE at age 70 years over time by sex and education

	Year	LE	Disability-Free LE (DFLE)[1]		Mild-Disability LE		Severe-Disability LE	
		Years	Years	95% CI	Years	95% CI	Years	95% CI
Sex								
Men	1995	11.9	8.0	(7.8 – 8.2)	3.1	(2.9 – 3.3)	0.8	(0.7 – 0.9)
	2006	13.9	10.8	(10.6 – 11.0)	2.6	(2.4 – 2.8)	0.5	(0.4 – 0.6)
	2017	15.3	12.1	(11.9 – 12.3)	2.5	(2.3 – 2.7)	0.7	(0.6 – 0.8)
Change 1995-2017		3.4	4.1	(3.4 – 4.5)	-0.6	(-1.0 – -0.2)	-0.1	(-0.3 – 0.1)
Women	1995	14.7	8.4	(8.2 – 8.6)	4.3	(4.1 – 4.5)	2.0	(1.8 – 2.2)
	2006	16.0	11.7	(11.5 – 11.9)	3.6	(3.4 – 3.8)	0.7	(0.6 – 0.8)
	2017	17.1	13.0	(12.8 – 13.2)	3.4	(3.2 – 3.6)	0.7	(0.6 – 0.8)
Change 1995-2017		2.4	4.6	(2.4 – 5.0)	-0.9	(-1.3 – -0.5)	-1.3	(-1.6 – -1.0)
Education[2]								
Men								
Basic	1995	11.1	7.4	(7.2 – 7.6)	2.9	(2.7 – 3.1)	0.8	(0.7 – 0.9)
	2006	12.8	9.8	(9.5 – 10.1)	2.5	(2.2 – 2.8)	0.5	(0.4 – 0.6)
	2017	13.7	10.5	(10.2 – 10.8)	2.5	(2.2 – 2.8)	0.7	(0.5 – 0.9)
Change 1995-2017		2.6	3.1	2.6 – 3.6)	-0.4	(-0.9 – 0.1)	-0.1	(-0.4 – 0.2)
High	1995	12.7	8.7	(8.3 – 9.1)	3.2	(2.8 – 3.6)	0.8	(0.5 – 1.1)
	2006	14.6	11.5	(11.1 – 11.9)	2.6	(2.2 – 3.0)	0.5	(0.3 – 0.7)
	2017	16.1	13.0	(12.7 – 13.3)	2.5	(2.2 – 2.8)	0.6	(0.4 – 0.8)
Change 1995-2017		3.4	4.3	(3.4 – 5.0)	-0.7	(-1.4 – 0.0)	-0.2	(-0.7 – 0.3)
Women								
Basic	1995	14.0	8.0	(7.8 – 8.2)	4.1	(3.9 – 4.3)	1.9	(1.7 – 2.1)
	2006	15.1	10.9	(10.6 – 11.2)	3.5	(3.2 – 3.8)	0.7	(0.6 – 0.8)
	2017	15.5	11.8	(11.5 – 12.1)	3.1	(2.8 – 3.4)	0.6	(0.5 – 0.7)
Change 1995-2017		1.5	3.8	1.5 – 4.3)	-1.0	(-1.5 – -0.5)	-1.3	(-1.6 – -1.0)
High	1995	16.2	9.8	(9.2 – 10.4)	4.7	(4.1 – 5.3)	1.7	(1.2 – 2.2)
	2006	17.2	12.8	(12.2 – 13.4)	3.9	(3.3 – 4.5)	0.5	(0.2 – 0.8)
	2017	18.5	14.5	(14.0 – 15.0)	3.3	(2.8 – 3.8)	0.7	(0.4 – 1.0)
Change 1995-2017		2.3	4.7	(2.3 – 5.8)	-1.4	(-2.5 – -0.3)	-1.0	(-1.8 – -0.2)

[1] Disability-Free = no IADL or PADL disability, Mild disability = IADL disability only, and Severe disability = PADL disability only or in combination with IADL disability

[2] Education was split into basic (9 years or less, ISCED 2011 level 1-2) and higher education (10+ years, ISCED 2011 level 3-8)

Table 3. Sex and educational inequalities in Life Expectancy (LE), Disability-Free LE (DFLE), Mild-Disability LE, Severe-Disability LE at age 70 years

	Year	LE	Disability-Free LE (DFLE)[1]		Mild-Disability LE		Severe-Disability LE	
Sex			Years	(95% CI)	Years	(95% CI)	Years	(95% CI)
	Women-men							
	1995	2.8	0.4	(0.0 – 0.8)	1.2	(0.8 – 1.6)	1.2	(0.9 – 1.5)
	2006	2.1	0.9	(0.5 – 1.3)	1.0	(0.6 – 1.4)	0.2	(0.0 – 0.4)
	2017	1.8	0.9	(0.5 – 1.3)	0.9	(0.5 – 1.3)	0.0	(-0.2 – 0.2)
Education[2]								
Men								
	High-basic							
	1995	1.6	1.3	(0.7 – 1.9)	0.3	(-0.3 – 0.9)	0.0	(-0.4 – 0.4)
	2006	1.8	1.7	(1.0 – 2.4)	0.1	(-0.6 – 0.8)	0.0	(-0.3 – 0.3)
	2017	2.4	2.5	(1.9 – 3.1)	0.0	(-0.6 – 0.6)	-0.1	(-0.5 – 0.3)
Women								
	High-basic							
	1995	2.2	1.8	(1.0 – 2.6)	0.6	(-0.2 – 1.4)	-0.2	(-0.9 – 0.5)
	2006	2.1	1.9	(1.0 – 2.8)	0.4	(-0.5 – 1.3)	-0.2	(-0.6 – 0.2)
	2017	3.0	2.7	(1.9 – 3.5)	0.2	(-0.6 – 1.0)	0.1	(-0.3 – 0.5)

[1] Disability-Free = no IADL or PADL disability, Mild disability = IADL disability only, and Severe disability = PADL disability only or in combination with IADL disability

[2] Education was split into basic (9 years or less, ISCED 2011 level 1-2) and higher education (10+ years, ISCED 2011 level 3-8)

Figure 1. Disability-Free LE (DFLE), Mild-Disability LE, Severe-Disability LE for men and women at age 70 years from 1995 to 2017, the HUNT Study, Norway

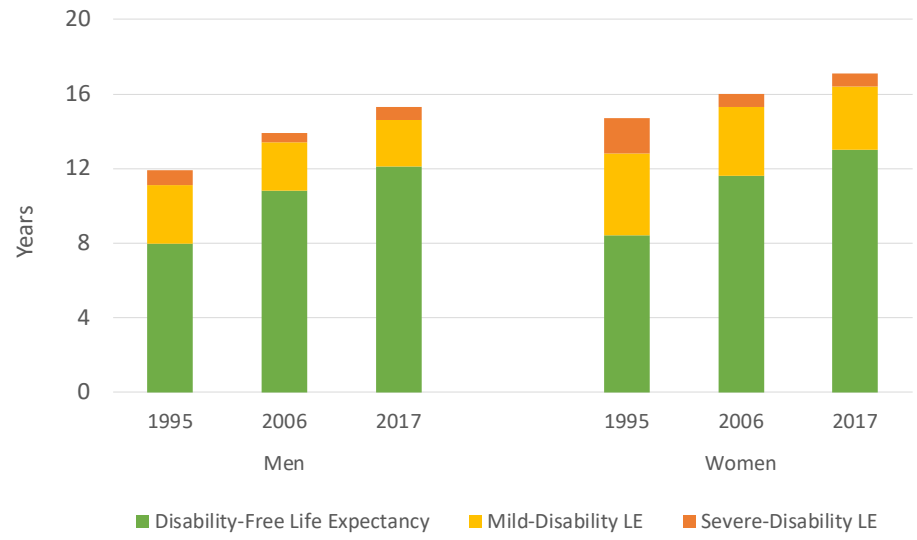

Figure 2. Difference in years between high and basic educational groups in disability-free life expectancy (DFLE), mild-disability LE and severe-disability LE for women and men at age 70 from 1995 to 2017, the HUNT Study, Norway*

*Negative values mean that the group with basic education had lower Severe-Disability LE than the higher educated group.