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European Journal of Public Health, Vol. 23, No. 4, 575–581

doi:10.1093/eurpub/cks136 Advance Access published on 4 October 2012

Aging and health in France: an unexpected expansion of disability in mid-adulthood over recent years

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Objectives: The study presents new disability-free life expectancies (DFLE) estimates for France and discusses recent trends in the framework of the three 'health and aging' theories of compression, dynamic equilibrium and expansion of disability. The objectives are to update information for France and to compare two methods to analyse recent trends. **Methods:** DFLE at ages 50, 65 and in the 50–65 age group are computed for several disability dimensions, using data from five French surveys over the 2000s. Owing to scarce time series, we used two methods to assess trends and consolidate our conclusions: (i) decomposition of the DFLE changes using the available time series; (ii) linear regression using all the available estimates, classified by disability dimensions. **Results:** Trends in $DFLE_{65}$ prolonged the dynamic equilibrium of the previous decades: increasing life expectancy with functional limitations but not with activity restrictions. Meanwhile, partial DFLE50–65 has decreased for various disability dimensions, including some activity restrictions, especially for women. **Conclusion:** France has recently experienced an unexpected expansion of disability in mid-adulthood while it is still on a trend of dynamic equilibrium at older ages. The study highlights the importance of monitoring trends in DFLE for various disability dimensions and broadens the scope of interest to the mid-adulthood.

Introduction

Increasing life expectancy (LE) raises the question of the quality of life during these extra years: are they healthy years or are we living longer with chronic illnesses and disabilities? In a context of increasing expectations for social participation in mid- and late adulthood, the assessment of health and functioning is essential to inform social policy and make provision for future pensions and long-term care systems.[1] Three possible scenarios for future trends in population health and adult life expectancy have dominated the debate since the 1980s: expansion of disability,[2] compression of morbidity[3] and a dynamic equilibrium between increased prevalence of disability and a reduction in its severity.[4] In this context, disability-free life expectancies (DFLE) have become key indicators for monitoring population health developments.[5]

Initial worldwide DFLE estimates indicated a *compression* of the period lived with severe forms of disability over the 1980s.[6] Gradually, the increasing number and variety of DFLE estimates made it possible to refine the conclusions and indicated a *dynamic equilibrium* during the 1990s: the years of life gained at older ages were not years with severe disability, even though they involved mild disability, physical or sensory functional limitations. In the early 2000s, several studies showed a continuation of the dynamic equilibrium of the 1990s,[7–13] whereas others provided evidence of an emerging expansion in some forms of severe disability in the elderly populations of Belgium, Japan and Sweden.[14,15] An expansion of poor health and disability was also highlighted in a number of studies which specifically focussed on mid-adult ages.[16–20]

France, like other countries, experienced a *compression* of disability over the 1980s and a *dynamic equilibrium* over the 1990s and up to the early 2000s.[21] New figures are available to update the information. But in France, as in many countries, trend analysis is still limited by the scarcity of robust time series. However, conclusions can be derived by comparing multiple data sources and identifying converging or diverging long-term trends.[1,21,22] This article has two objectives: to update information about recent DFLE in France and to compare two methods for analysing trends. The first is based on accurate, but scarce, repeated surveys, and the second is based on the numerous, but not directly comparable, one-off surveys. We examine DFLE trends not only for the elderly population (65+), on whom most studies concentrate, but also for the population aged 50+. Because public policy is based on the expectation of greater social participation in mid-adulthood, and because some forms of disability have already occurred at these ages, we believe it has become important to broaden our scope and to monitor functional health in this age group too.

Methods

Data

We focused on recent trends in French DFLE, between 2003 and 2008, to prolong previous estimations.[21] We used five population health surveys conducted over this period by the French national statistical office (INSEE), the health ministry's directorate for research, evaluation and statistics (DREES) and the French institute for health economics research and documentation (IRDES) (see table 1 for the full names and characteristics of the surveys). Samples range in size from 3000 to 14 000 respondents, representative of community-dwelling households. The IRDES sample is based on the files of the French Social Security (health insurance). The other samples were drawn from the 1999 census files. The questionnaires comprise a variety of indicators based on self-reported difficulties in daily living, representing six specific dimensions of the disablement process models.[23]

Disability dimensions and indicators

Functional limitations (FL), such as difficulties in seeing, walking, remembering, etc., are the consequence of disabling conditions on

Table 1 Overview of the most recent population health surveys used to calculate DFLE indicators in metropolitan France

Survey	Survey characteristics				Functional limitation DFLE (number of questions on functional limitations)			Activity restriction DFLE (mumber of questions on restrictions on activity)		
	Year	Data collection	Ages Response rate (RR)	Sample size (50+) (unweighted % of the 65+ among the 50+)[a]	Physical FL	Sensory FL	Mental/cognitive FL	ADL	IADL	GALI or similar
ESSM	2002–03	Face-to-face	All ages RR = 78% households	13 446 (46%)	1*DFLE_FLphy *(6)*	1*DFLE_FLsens *(3)*	–	1*DFLE_ADL *(6)*	1*DFLE_IADL *(6)*	1*DFLE_GALI *(1)*
HSM	2008	Face-to-face	All ages RR2008 = 78%	13 682 (52%)	1*DFLE_FLphy *(5)*	1*DFLE_FLsens *(3)*	1 DFLE_FLcog *(8)*	1*DFLE_ADL *(7)*	1*DFLE_IADL *(6)*	1*DFLE_GALI *(1)*
SILC	2004	Face-to-face	Age ≥ 16 RR = 84–86%	7969 (45%)	–	–	–	–	–	4*DFLE_GALI *(1)*
	2005		households (99%	7857 (44%)						
	2006		individuals)	8302 (44%)						
	2007			8832 (44%)						
SHARE	2004	Face-to-face	Age ≥ 50	3038 (46%)	[b]	–	–	2*DFLE_ADL *(5)*	2*DFLE_IADL *(7)*	2*DFLE_GALI *(1)*
	2006		RR2004 = 81% households (91% individuals)	2871 (49%)						
ESPS	2006	Mail/Face-to-face for ages ≥ 65	All ages	5623 (41%)	2*DFLE_FLphy *(3)*	2*DFLE_FLsens *(3)*	2*DFLE_FLcog *(1)*	1*DFLE_ADL *(1)*	–	2*DFLE_GALI *(1)*
	2008		RR2006 = 63% RR2008 = 66% (≅78% returned health section)	5621 (41%)						

Number of DFLE single estimates (1*) or time series (n*) and number of question items used *(n)*.
Population of reference: metropolitan France, population of community dwellings.
a: According to 2008 census figures, persons aged ≥ 65 account for 46% of ordinary households aged > 50 in metropolitan France.
b: The SHARE questionnaire comprises items to measure FLphy based on more items than the other questionnaires, including 'moving furniture', so the indicator is not comparable with the other one. We did not use this indicator in this article, but estimates can be found in the report Sieurin-Blachier *et al*.[29]
Data sources: ESSM, Enquête sur la santé et les soins médicaux (survey on health and health consumption), by INSEE; HSM, Handicap santé en ménages (household survey on disability and health), by INSEE and DREES; SILC, EU-Statistics on income and living conditions, by Eurostat and INSEE; SHARE, Survey of health, aging and retirement in Europe, run in France by IRDES and INSEE; ESPS, Enquête sur la santé et la protection sociale (survey on health and social protection), by IRDES.
Disability indicators: DFLE, FLphy, FLsens, FLcog, GALI, IADL and ADL.

bodily functions. Three dimensions of FL were considered (sensory FL, physical/motor FL and cognitive/mental FL). FLs are associated with specific needs—for assistive devices, rehabilitation, home or workplace adaptation, for example—to compensate for the limitations experienced. When they are not compensated, FLs may generate difficulties in performing daily activities [or activity restrictions (ARs)]. ARs reflect more severe disability, involving (progressive) loss of autonomy and need of assistance. Three dimensions of AR are considered (difficulties in personal care activities, instrumental/chore activities, general activity limitations). The determinants of FL are both risks of exposure to disabling diseases and the level of access to care; the determinants of AR are both types of FL and availability of resources to facilitate coping strategies. Distinguishing between FL and AR makes it possible to characterize specific patterns over time, or by sex and age. Indicators can be computed from the five available surveys.

FL indicators are measured by questions inspired by Nagi's items,[24] asking people about difficulties:

(i) in hearing and seeing that are not (or poorly) corrected by devices for sensory FLs (FLsens);
(ii) in walking, bending down, grabbing and reaching for physical/motor FLs (FLphy);
(iii) and in remembering, understanding, orientating, behaving inappropriately, etc. for cognitive/mental FLs (FLcog).

Four DFLE_FLsens, five DFLE_FLphy and two DFLE_FLcog estimates were calculated, some of which provide time trends (table 1).

AR indicators are based on reported difficulties or need of assistance either for personal care activities of daily living (ADL) (washing, eating, dressing, etc.)[25] or for chore/instrumental activities of daily living (IADL).[26] The global activity limitation indicator (GALI) measures more general AR to identify difficulties occurring before age 65 years, when people are not yet much concerned by ADL or IADL disability.[27] Five DFLE_ADL, three DFLE_IADL and five DFLE_GALI were calculated; some provide time trends (table 1).

Statistical analysis

Total and partial DFLE

DFLE were estimated using the Sullivan's method.[5] The person-years of regular period life tables for metropolitan France (INSEE) were broken down into years spent with and without disability using the age-specific disability prevalence from the surveys. While the latter do not account for the long-term care (LTC) population, we also consider the person-years lived by the residents of nursing homes and LTC services as years of disability in order to avoid under-representing the disability life expectancy (DLE). DFLE at age x is the sum of remaining person-years without disability (from age x) as a ratio of those surviving to age x. We computed DFLE at age 50 and at age 65 to present the aggregate indicators. Additionally, partial DFLEs between the ages of 50 and 65 were computed to assess how much disability occurred before the age of 65, broadening the concept of premature mortality to that of premature disability. The confidence intervals were calculated from the sample size of each survey in each age group.[28] All the calculations can be seen in detail.[29]

Trend analysis

Decomposition technique For the few available time series (SHARE 2004 and 2006, ESPS 2006 and 2006 and EU-SILC 2005 and 2008), the decomposition method can be used to reflect the simultaneous dynamics in mortality and disability.[30] The reduction in mortality increases the probability of survival both for those with disabilities and those without (mortality effect). At the same time, the increase or reduction in the age-specific incidence of disability impacts the overall disability prevalence (disability effect). Decomposition allows distributing the years of LE gained between years with and without disability and identifying the changes attributed to mortality changes and to disability changes (box 1). For each of the three repeated surveys, we present the variations in LE and DFLE between the first and last rounds (t_1 and t_2); the variation in the ratio (DLE/LE) indicates the extension or compression over time of the period lived with disability within LE.

Box 1 Decomposition of variations in DFLE and DLE

The variation in disability-free person-years ($\Delta DFPY$) over time (between the dates t_1 and t_2) in each age group is the result of the variation in mortality represented by the number of person-years (PY) in the age group x and the variation in disability prevalence (Π). The decomposition method seeks to separate the components relating to variation in disability (dis) from those relating to mortality (mor). The variation in person-years with disability (ΔPY) is decomposed in the same manner.

$$\Delta DFPY = [\Delta DFPY_{mor}] + [\Delta DFPY_{dis}]$$

$$\Delta DFPY = \left\{\sum_x \left(\frac{\Pi x_{t1} + \Pi x_{t2}}{2}\right) \times (PYx_{t2} - PYx_{t1})\right\} + \left\{\sum_x \left(\frac{PYx_{t1} - PYx_{t2}}{2}\right) \times (\Pi x_{t2} + \Pi x_{t1})\right\}$$

The components in person-year variations (as a ratio of the survivors in the life table) enable us finally to present the trends in LE as follows:

$$\Delta LE = \Delta DFLE + \Delta DLE$$

$$\Delta LE = (\Delta DFLE_{mor} + \Delta DFLE_{dis}) + (\Delta DLE_{mor} + \Delta DLE_{dis})$$

Linear regression The series used for decomposition are short, and the sample size and number of disability indicators are limited. To consolidate our conclusions, we supplemented the decomposition analysis with a second method, using all five surveys. Even if the estimates derived from different sources are not directly comparable, the previous French study showed that dimension-specific estimates computed from different sources are close and present very similar patterns.[21] We therefore consider that the DFLE estimates computed at different dates from different surveys can be used to give a sense of the trend direction by age group, sex or disability dimension, and highlight divergence or convergence with the conclusions based on the time series.

For each disability dimension, we plotted the DFLE estimates computed with the five surveys between 2003 and 2008 and deduced time trends based on a linear regression on these point-in-time estimates:

(1) Trends in DFLE_ADL based on the following estimates: DFLE_ADL_ESSM 2003; DFLE_ADL_SHARE 2004 and 2006; DFLE_Toilette_ESPS 2006 and 2008; DFLE_ADL_HSM 2008.
(2) Trends in DFLE_GALI based on the following estimates: DFLE_GALI_SILC 2005 to 2008; DFLE_GALI_ESPS 2006 and 2008; DFLE_GALI_HSM 2008; DFLE_GALI_SHARE 2004 and 2008.
(3) Trends in DFLE_IADL based on the following estimates: DFLE_ IADL_HSM 2008; DFLE_IADL_SHARE 2004 and 2008; DFLE_IADL_ESSM 2003.
(4) Trends in DFLE_FLphy based on the following estimates: DFLE_FLphy_ESSM 2003; DFLE_FLphy_SHARE 2004 and 2006; DFLE_FLphy_ESPS 2006 and 2008; DFLE_FLphy_HSM 2008.

Table 2 Total and partial LE, DLE and DFLE at selected ages ($\geq$50 years, 50–64 years, $\geq$65 years) in metropolitan France, in 2008

Men	LE, DFLE, DLE at age 50			Partial LE, DFLE, DLE in 50 – 64 age group			LE, DFLE, DLE at age 65		
LE	LE_{50} = 30.1 years			$LE_{50–64}$ = 14.2 years			LE_{65} = 18.2 years		
	DFLE (95% CI)	DLE	%DFLE/LE	DFLE (95% CI)	DLE	%DFLE/LE	DFLE (95% CI)	DLE	%DFLE/LE
FLphy/sens_HSM	13.9 (13.4 – 14.4)	16.2	(46)	9.1 (9.0 – 9.3)	5.1	(64)	5.5 (5.0 – 5.9)	12.8	(30)
FLcog_ESPS	26.1 (26.0 – 26.3)	3.7	(87)	13.1 (13.1 – 13.1)	1.1	(92)	14.9 (14.7 – 15.0)	3.4	(82)
FLcog_HSM	25.8 (25.7 – 25.9)	4.3	(86)	12.8 (12.8 – 12.9)	1.4	(90)	14.9 (14.8 – 15.0)	3.4	(82)
FLsens_ESPS	21.2 (20.8 – 21.5)	9.0	(70)	11.4 (11.2 – 11.5)	2.8	(80)	11.2 (10.8 – 11.6)	7.0	(61)
FLsens_HSM	18.3 (18.0 – 18.6)	11.8	(61)	10.6 (10.5 – 10.7)	3.6	(75)	8.8 (8.5 – 9.2)	9.4	(48)
FLphy_ESPS	21.4 (21.0 – 21.8)	8.7	(71)	12.2 (12.1 – 12.3)	2.0	(86)	10.5 (10.0 – 11.0)	7.7	(58)
FLphy_HSM	20.3 (20.0 – 20.6)	9.8	(67)	11.8 (11.7 – 11.9)	2.4	(83)	9.7 (9.4 – 10.1)	8.5	(53)
GALI_SILC	17.6 (17.1 – 18.1)	12.5	(58)	10.3 (10.2 – 10.5)	3.9	(73)	9.3 (8.8 – 9.9)	8.9	(51)
GALI_ESPS	18.6 (18.1 – 19.0)	11.6	(62)	10.4 (10.2 – 10.5)	3.8	(73)	10.4 (9.9 – 10.8)	7.9	(57)
GALI_HSM8	17.4 (17.1 – 17.8)	12.7	(58)	10.2 (10.1 – 10.4)	4.0	(72)	8.3 (7.9 – 8.6)	10.0	(45)
IADL_HSM	26.3 (26.1 – 26.4)	3.9	(87)	13.5 (13.4 – 13.5)	0.7	(95)	14.7 (14.5 – 14.8)	3.6	(80)
ADL_HSM	27.3 (27.2 – 27.3)	2.9	(90)	13.6 (13.6 – 13.6)	0.6	(96)	15.6 (15.5 – 15.7)	2.7	(85)
Toilette_ESPS	27.2 (27.1 – 27.3)	2.9	(90)	13.4 (13.4 – 13.4)	0.8	(95)	15.8 (15.6 – 15.9)	2.5	(86)
Women	**LE, DFLE, DLE at age 50**			**Partial LE, DFLE, DLE in 50 – 64 age group**			**LE, DFLE, DLE at age 65**		
LE	LE_{50} = 35.9 years			$LE_{50–64}$ = 14.6 years			LE_{65} = 22.5 years		
	DFLE (95% CI)	DLE	%DFLE/LE	DFLE (95% CI)	DLE	%DFLE/LE	DFLE (95% CI)	DLE	%DFLE/LE
FLphy/sens_HSM8	13.5 (13.0 – 14.0)	22.4	(38)	8.4 (8.2 – 8.6)	6.3	(57)	5.5 (5.0 – 6.0)	17.0	(24)
FLcog_ESPS	30.1 (29.9 – 30.3)	5.6	(84)	13.3 (13.3 – 13.4)	1.3	(91)	17.8 (17.5 – 18.0)	4.7	(79)
FLcog_HSM	30.2 (30.1 – 30.3)	5.6	(84)	13.4 (13.4 – 13.5)	1.2	(92)	17.8 (17.7 – 17.9)	4.7	(79)
FLsens_ESPS	24.9 (24.4 – 25.4)	11.0	(69)	12.1 (12.0 – 12.2)	2.5	(83)	13.5 (13.0 – 14.0)	9.0	(60)
FLsens_HSM	23.6 (23.3 – 23.9)	12.3	(66)	11.8 (11.7 – 11.9)	2.8	(81)	12.5 (12.2 – 12.8)	10.0	(55)
FLphy_ESPS	21.7 (20.9 – 22.5)	14.2	(61)	12.4 (12.3 – 12.5)	2.3	(84)	9.9 (9.1 – 10.7)	12.6	(44)
FLphy_HSM	16.9 (16.5 – 17.4)	18.9	(47)	10.1 (9.9 – 10.2)	4.6	(69)	7.3 (6.8 – 7.7)	15.2	(32)
GALI_SILC	19.2 (18.5 – 19.8)	16.7	(53)	10.5 (10.3 – 10.6)	4.2	(72)	9.2 (8.6 – 9.9)	13.3	(41)
GALI_ESPS	21.2 (20.5 – 21.8)	14.7	(59)	11.0 (10.8 – 11.1)	3.7	(75)	10.8 (10.1 – 11.5)	11.7	(48)
GALI_HSM	18.5 (18.1 – 18.9)	17.3	(52)	9.9 (9.8 – 10.1)	4.7	(68)	9.1 (8.7 – 9.5)	13.4	(41)
IADL_HSM	26.9 (26.7 – 27.2)	8.9	(75)	13.4 (13.4 – 13.5)	1.2	(92)	14.3 (14.1 – 14.6)	8.2	(64)
ADL_HSM	31.0 (30.9 – 31.2)	4.8	(87)	14.2 (14.1 – 14.2)	0.5	(97)	17.9 (17.8 – 18.0)	4.6	(80)
Toilette_ESPS	30.4 (30.2 – 30.7)	5.4	(85)	14.2 (14.2 – 14.2)	0.5	(97)	17.2 (17.0 – 17.5)	5.3	(77)

Disability indicators: FLphy, FLsens, FLcog, GALI, IADL and ADL.
Surveys: HSM: Handicap Santé en Ménages 2008; ESPS: Enquête santé et protection sociale 2008; SILC: Study on income and living conditions 2008.

(5) Trends in DFLE_FLsens based on the following estimates: DFLE_FLsens_ESSM 2003; DFLE_FLsens_SHARE 2004 and 2006; DFLE_FLsens_ESPS 2006 and 2008; DFLE_FLsens_HSM 2008.
(6) Trends in DFLE_FLcog based on the following estimates: DFLE_FLcog_ESPS 2006 and 2008; DFLE_FLcog_HSM 2008.

The parameters of the regression allowed us to compute average DFLE estimates for 2003 and 2008 for each of the six dimensions, and to assess disability-specific changes in LE and DFLE and in the DLE/LE ratio.

Based on the results of the two methods, we discuss trends in disability over time by age group and gender.

Results

Disability-free life expectancy in France in 2008

LE at age 50 (LE_{50}) in 2008 is 30 years for men and 36 years for women; only 14 years of which, on average, are free of FLphy and FLsens (~40% of LE) while $DFLE\_FLcog_{50}$ is much longer. $DFLE\_IADL_{50}$ is virtually the same for both sexes, but owing to their longer life, women live for twice as long as men with such restrictions. DLE_GALI_{50} correspond to around 40% of men's LE_{50} and 50% of women's LE_{50}, and DLE_ADL_{50} around 10% (table 2). Women meet difficulties for ADL later than men, but they encounter FLs and other ARs at around the same age, or even earlier for FLphy. Table 2 confirms the proximity of DFLE estimates based on the same disability dimensions, noting that the ESPS estimates are usually significantly higher.

In 2008, partial $LE_{50–65}$ is close to the 15 years that can be lived in this segment (95% for men and 97% for women). Partial $DFLE\_FL_{50–65}$ and $DFLE\_GALI_{50–65}$ account for two-third of the $LE_{50–65}$. FLcog, IADL or ADL restrictions also occur before age 65, and DLE for these dimensions represents around 5% of the $LE_{50–65}$. Women still generally spend more years with disability than men in this age group.

At age 65, DLE_FLphy and DLE_FLsens account for 70% of men's LE_{65} and 75% of women's. But still, the majority of the LE years are free of severe disability: DLE_ADL_{65} represents 15% of men's LE_{65} and 20% of women's. Comparison of men and women leads to the same conclusions at ages 50 and 65.

Decomposition of changes in DFLE over 2004–08

Table 3 presents the decomposition of changes in $DFLE_{50}$, $DFLE_{50–65}$ and $DFLE_{65}$, showing contrasting patterns between sexes and age groups. At age 50, male and female patterns are almost reversed. Gains in LE_{50} correspond to more years with (than without) GALI and FLcog for men but not for women and to more years with FLsens, IADL and ADL restrictions for women but not for men. Both sexes have gained more years with, than without, FLphy. Distinguishing 50–64 and 65 + age groups provides further insights.

For both sexes, the decrease (or limited increase) in the $DFLE_{50–65}$ estimates leads to an expansion in $DLE_{50–65}$ within $LE_{50–65}$, for all disability dimensions except two: men's FLphy and ADL restrictions. Gains in partial $LE_{50–65}$ are very small, therefore changes are due solely to changes in disability.

Table 3 Decomposition of life expectancy gains into disability-free years [number of years gained due to mortality (Mort) or to disability (Dis)] and changes in the proportion of years with disability within life expectancy (↓: compression; ↑: expansion in DLE/LE)

	ΔLE and ΔDFLE at age 50			ΔLE and ΔDFLE in 50 − 65 age group			ΔLE and ΔDFLE at age 65		
	ΔLE	ΔDFLE (Mort+/−Dis)	Δ(DLE/LE) ↑/↓	ΔLE	ΔDFLE (Mort+/−Dis)	Δ(DLE/LE) ↑/↓	ΔLE	ΔDFLE (Mort+/−Dis)	Δ(DLE/LE) ↑/↓
Men									
FLcog_ESPS2006 and 2008	0.33	0.08 (0.25 − 0.17)	↑ +0.007	0.02	0.01 (0.02 − 0.01)	↑ +0.001	0.30	0.04 (0.22 − 0.18)	↑ +0.011
FLsens_ESPS2006 and 2008	0.33	0.26 (0.18 + 0.08)	↓ −0.001	0.02	−0.27 (0.02 − 0.29)	↑ +0.020	0.30	0.57 (0.15 + 0.42)	↓ −0.022
FLphy_ESPS2006 and 2008	0.33	0.17 (0.15 + 0.02)	↑ +0.002	0.02	0.08 (0.02 + 0.06)	↓ −0.004	0.30	0.07 (0.13 − 0.05)	↑ +0.005
GALI_ESPS2006 and 2008	0.33	−1.26 (0.16 − 1.41)	↑ +0.049	0.02	−0.39 (0.02 − 0.41)	↑ +0.029	0.30	−1.02 (0.13 − 1.15)	↑ +0.065
GALI_SHARE2004 and 2006	0.51	−0.41 (0.19 − 0.60)	↑ +0.024	0.02	−0.74 (0.02 − 0.75)	↑ +0.053	0.48	0.33 (0.16 + 0.17)	↓ −0.006
GALI_SILC2005 and 2008	0.48	−0.05 (0.17 − 0.22)	↑ +0.011	0.03	−0.37 (0.02 − 0.39)	↑ +0.027	0.45	0.33 (0.15 + 0.19)	↓ −0.007
IADL_SHARE2004 and 2006	0.51	0.58 (0.30 + 0.28)	↓ −0.005	0.02	−0.11 (0.02 − 0.13)	↑ +0.009	0.48	0.74 (0.27 + 0.47)	↓ −0.021
ADL_SHARE2004 and 2006	0.51	1.42 (0.35 + 1.07)	↓ −0.034	0.02	0.03 (0.02 + 0.01)	→ 0.000	0.48	1.55 (0.32 + 1.23)	↓ −0.066
Women									
FLcog_ESPS2006 and 2008	0.18	1.28 (0.13 + 1.15)	↓ −0.031	0.00	−0.37 (0.00 − 0.37)	↑ +0.025	0.18	1.74 (0.13 + 1.61)	↓ −0.071
FLsens_ESPS2006 and 2008	0.18	−0.04 (0.11 − 0.15)	↑ +0.005	0.00	−0.72 (0.00 − 0.72)	↑ +0.049	0.18	0.72 (0.11 + 0.61)	↓ −0.027
FLphy_ESPS2006 and 2008	0.18	−2.15 (0.08 − 2.23)	↑ +0.063	0.00	−2.82 (0.00 − 2.82)	↑ +0.193	0.18	0.71 (0.08 + 0.63)	↓ −0.028
GALI_ESPS2006 and 2008	0.18	0.21 (0.09 + 0.12)	↓ −0.003	0.00	−0.79 (0.00 − 0.79)	↑ +0.054	0.18	1.06 (0.09 + 0.96)	↓ −0.043
GALI_SHARE2004 and 2006	0.51	1.76 (0.24 + 1.53)	↓ −0.042	0.01	−0.25 (0.01 − 0.26)	↑ +0.018	0.51	2.12 (0.23 + 1.89)	↓ −0.086
GALI_SILC2005 and 2008	0.31	0.71 (0.13 + 0.58)	↓ +0.015	0.00	−1.13 (0.00 − 1.13)	↑ +0.077	0.31	1.94 (0.13 + 1.81)	↓ −0.081
IADL_SHARE2004 and 2006	0.51	0.15 (0.25 − 0.11)	↑ +0.006	0.01	−0.86 (0.01 − 0.87)	↑ +0.060	0.51	1.05 (0.24 + 0.81)	↓ −0.034
ADL_SHARE2004 and 2006	0.51	0.23 (0.33 − 0.10)	↑ +0.005	0.01	−0.54 (0.01 − 0.55)	↑ +0.037	0.51	0.80 (0.32 + 0.48)	↓ −0.009

Disability indicators: FLphy, FLsens, FLcog, GALI, IADL and ADL.
Surveys: ESPS: Enquête santé et protection sociale 2006 and 2008; SILC: Study on income and living conditions 2005−08; SHARE: Survey on health, aging and retirement in Europe 2004 and 2006.

Table 4 Percentage change between 2003 and 2008 for life expectancies (%ΔLE) and the estimated disability-free life expectancies (%ΔDFLE′) calculated from linear regression (2003−08). Corresponding change in the proportion of estimated years with disability (↓: compression; ↑: expansion in DLE′/LE)[a]

	ΔLE and ΔDFLE at age 50			ΔLE and ΔDFLE in 50−65 age group			ΔLE and ΔDFLE at age 65		
	%ΔLE	%ΔDFLE′	ΔDLE′/ΔLE ↑/↓	%ΔLE	%ΔDFLE′	ΔDLE′/ΔLE ↑/↓	%ΔLE	%ΔDFLE′	ΔDLE′/ΔLE ↑/↓
Men									
DFLE_FLcog	+4.1	−1.0	↑ +0.045	+0.4	−2.7	↑ +0.029	+6.7	+0.2	↑ +0.052
DFLE_FLsens	+4.1	−0.8	↑ +0.033	+0.4	−3.7	↑ +0.033	+6.7	−2.5	↑ +0.025
DFLE_FLphy	+4.1	+1.7	↑ +0.017	+0.4	+1.3	↓ −0.008	+6.7	−1.4	↑ +0.025
DFLE_GALI	+4.1	+0.2	↑ +0.023	+0.4	−0.4	↑ +0.006	+6.7	+0.8	↑ +0.013
DFLE_IADL	+4.1	+4.8	↓ −0.006	+0.4	<0.0	↑ +0.004	+6.7	+4.3	↓ −0.020
DFLE_ADL	+4.1	+6.6	↓ −0.021	+0.4	+1.0	↓ −0.006	+6.7	+5.9	↓ −0.040
Women									
DFLE_FLcog	+2.8	+3.6	↓ −0.006	+0.1	−0.7	↑ +0.007	+4.6	+7.1	↓ −0.019
DFLE_FLsens	+2.8	−5.2	↑ +0.057	+0.1	−5.5	↑ +0.048	+4.6	−5.1	↑ +0.059
DFLE_FLphy	+2.8	−1.7	↑ +0.026	+0.1	−2.5	↑ +0.020	+4.6	−0.9	↑ +0.022
DFLE_GALI	+2.8	+2.9	↓ −0.001	+0.1	−1.1	↑ +0.008	+4.6	+7.6	↓ −0.012
DFLE_IADL	+2.8	+5.3	↓ −0.017	+0.1	<0.0	↑ +0.001	+4.6	+11.5	↓ −0.038
DFLE_ADL	+2.8	+4.3	↓ −0.012	+0.1	+1.4	↓ −0.012	+4.6	+6.7	↓ −0.016

Information source used in the linear regression:
Disability indicators: DFLE, FLphy, FLsens, FLcog, GALI, IADL and ADL.
Data sources: ESPS: Enquête santé et protection sociale 2006 and 2008; EU-SILC: Study on income and living conditions 2005−08; SHARE: Survey on health, aging and retirement in Europe 2004 and 2006; HSM: Handicap santé en menage 2008; HID: Handicaps, incapacites, dependance 1999; ESSM: Enquete santé et soins médicaux 2003.
a: DFLE′ and DLE′ estimates are computed for the years 2003 and 2008 using the linear regression parameters.
$\%\Delta LE = (LE_{2008} - LE_{2003})/LE_{2003}$ || $\%\Delta DFLE' = (DFLE'_{2008} - DFLE'_{2003})/DFLE'_{2003}$ || $\Delta(DLE'/LE) = (DLE'_{2008}/LE_{2008}) - (DLE'_{2003}/LE_{2003})$.

Conversely at age 65, there is a compression of DLE, owing to a larger increase in $DFLE_{65}$ within LE_{65}, for FLsens, ADL, IADL and GALI (except for one out of the three male GALI estimates) and additionally for women's FLcog, FLphy. The increase in $DFLE_{65}$ is generally due to both the increased LE_{65} (which has contributed more to DFLE than to DLE) and the reduction in reported disability. For men's FLcog and FLphy, $DFLE_{65}$ has increased less than the DLE_{65}; the increasing prevalences have partially offset the gains in $DFLE_{65}$ resulting from reduced mortality.

Change in LE, DFLE and in the DLE/LE ratio based on both methods

Table 4 presents the results from the linear regression. In the 50–65 age group, both methods conclude to an expansion of DLE for all disability dimensions except for male FLphy, for which they indicate a compression, and for ADL, for which the methods diverge. The decomposition also indicates an expansion of DLE_ADL for women and stagnation for men while the regression indicates a compression for both sexes. The decrease in DFLE is generally more pronounced for women.

After age 65, both methods conclude to a compression of DLE for ADL, IADL and women's GALI and FLcog and to an expansion for male DLE_FLcog and DLE_FLphy. Results are divergent for female FLsens and FLphy and of male FLsens and GALI, for which the regression indicates an expansion and the decomposition a compression.

Discussion

In 2008, years of FL accounted for >50% of LE_{50} and >70% of LE_{65}. However, this does not automatically mean years of AR, which represent only about 40% of LE_{50} and half of LE_{65}. Women spend on average more years with disability than men especially for LFphys and IADL. Although disabilities are more frequent at higher ages, some occur before age 65: one-third of the partial $LE_{50–65}$ is affected by FL and 25% by AR.

Over the 2000s, population health maintained the dynamic equilibrium previously observed in the elderly population[21]: both methods conclude to an expansion of the DLE for FLphy, FLsens, and for male GALI and FLcog, but a compression for the AR (ADL and IADL) and for female GALI. Interestingly, both methods conclude to a decrease in female DLE_FLcog. As in the previous decades, these trends generally illustrate the increasing prevalence with age of common FL, but reveal the growing ability of people to cope with them and to continue performing elementary activities.[31] These results underline the continuing efforts required in future years to address FL and to facilitate coping strategies to prevent AR. It is also worth noting that a larger increase (or a smaller decrease) in DFLE for women than for men, except for ADL, has narrowed the gender gap in DLE after age 65.

In the 50–65 age group, the results indicate a decrease in most DFLE, except for ADL and men's FLphys; the decrease is larger for women, leading to an increased gender gap in DLE. The results suggest that men and women in these generations could be more affected by disabling conditions than in previous generations and, consequently, experience more FL but also more difficulties in IADL and general activities. This new worrying result should be discussed and further explained in the light of health and social changes. But first, several methodological limitations need to be mentioned.

Among the limitations to be considered, the variation in surveys questionnaires, survey design and samples prevented us from making direct comparisons of the estimates over time.[32] They were also probably responsible for some of the inconsistencies between the two methods used to assess trends. ESPS presented higher DFLE estimates than the other surveys and also indicated an expansion of DLE at older ages (for female FLphy or FLsens and male GALI) while the regression based on the five sources rather reflected a compression. The different sampling procedures as well as the lower response rate for ESPS (which was even lower in 2006 than in 2008) may account for the relatively low and increasing prevalence in mild disability in this sample. The extent to which the selected sample altered trend estimates cannot be evaluated. But the multi-source approach allows us to point up and discuss these inconsistencies[22] and actually shows that in most cases, the estimates and trends are convergent. The results confirm the general robustness of the indicators and the relevance of a multi-source approach to make up for the scarcity of time series and to analyse contrasting patterns.

Another issue relates to the use of cross-sectional data and the Sullivan's method to compute DFLE based on prevalence rather than on disability incidence and recovery (not available in French population-based surveys). The estimates reflect both current and past health conditions rather than only current ones and cannot answer the question on longer survival with or without disability. However, a study shows that although this method leads to an under-estimation of DFLE, the deviations remain moderate.[33]

Despite these limitations, the study indicates an unexpected expansion in disability years, which contrasts with previous French results, but which is actually consistent with other recent studies. In the United States, disability among people aged 50–70, including disability with need of assistance for IADL or ADL, has increased,[17,18] particularly among women, the obese and the low educated.[20] Early baby boomers (born between 1948 and 1953) reported more poor health and work limitations than previous cohorts and, controlling for education, they also reported a larger number of FLs and/or ARs.[19] A Swedish study showed that in late working ages, DFLE_FL has declined and DFLE_ADL has stopped increasing since the1990s.[8] The expansion of DLE in France adds to this literature and points up the potential increase in needs and decrease in capacity for social participation among this age group, an important issue for health and social policy.

The $DLE_{50–65}$ expansion may be partly due to a reporting effect, while better diagnosis together with greater knowledge and expectations for health may be raising awareness and the likelihood of reporting disability. This could apply particularly to men and women of these generations who are better educated and informed than in previous ones. But the $DLE_{50–65}$ expansion could also be the result of a real increase in disability prevalence, and causes could be explored in three directions. First, improvement in treatments has decreased the lethality of certain chronic conditions; this increased the survival with these diseases and with associated disabilities, as seen among elderly Americans.[13] Second, behaviour changes over previous decades in France, such as tobacco consumption and diet,[34] have possibly increased the prevalence of FL, especially in women, while smoking and obesity are strongly associated with disability.[35–37] The extent to which these possible changes have been compensated by the concurrent benefits of improved care and the positive effect of increasing educational level of the baby boomers is debated and should be further explored. Third, social changes, particularly in the labour market, have modified exposure to both physical and mental health risks for a part of the population, especially at late working ages. Weir's study indicated a higher level of work limitations in the baby boomers, as well as more pain and arthritis.[19] This could be linked to an increase in DLE_FL (although we found a decrease in FLphy for men) and in DLE_GALI; it is worth noting that GALI measure is influenced by activity status in France, with inactive persons being more inclined to report GALI.[38] The link between the expansion in $DLE_{50–65}$ and work could also explain the larger expansion found for the female population, due to the massive increase in female labour market participation that started with the baby-boom generations. These women also combined careers, care-giving and domestic activities, with a possible impact on their health and in their functioning.[39,40] The expansion of women's DLE_GALI and DLE_IADL may reflect their growing number of roles and activities and the consequent increased exposure to health risks, but it may also reflect the increasing difficulties experienced by some of them in combining all these activities, particularly when their health is declining. Finally, if increasing DLE is partly linked to work conditions, the increase in DLE among the 50–65 years age group in France may further widen the (already large) occupational inequalities in $DFLE_{50–65}$, and raise questions about inequalities in the chances of remaining in work until retirement age.[41]

France has successively illustrated the 'three theories' on health and aging over 3 decades. Where it followed a pattern of compression of disability in the 1980s and of dynamic equilibrium in the 1990s,[21] it now appears to be experiencing an expansion for some disability dimensions in the 50–65 age group. In this context, health and functioning in late working ages, the role of work conditions on health, and finally the ability to remain active in

spite of poor health have become crucial issues. Our results highlight the need to further explore the mechanism of this emerging trend at the population level. Will it remain specific to this generation or may it also affect the following ones? The results call for further research on trends in DFLE and on its determinants with a view to maintaining functioning and participation in both mid and older-adulthood.

Key points

- At age 65, life expectancies without severe disability have continued to increase in recent years in France and the gender gap has narrowed.
- For some disabilities, onset occurs in mid-adulthood, especially for women, and our results indicate an unexpected expansion of certain disability dimensions at these ages.
- The use of various disability dimensions and a multi-source approach are useful for monitoring health and highlighting sex- and age-specific trends.
- Health and functioning should be monitored not only for the elderly population but also in mid-adult ages and in the baby-boom generations.

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