


# BMJ Open Use of healthcare services and assistive devices among centenarians: results of the cross-sectional, international 5-COOP study

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## ABSTRACT

**Objectives** To measure the use of healthcare services and assistive devices by centenarians in five countries.

**Design** Cross-sectional study using a survey questionnaire.

**Setting** Community-dwelling and institutionalised centenarians living in Japan, France, Switzerland, Sweden and Denmark.

**Participants** 1253 participants aged 100 or in their 100th year of life, of whom 1004 (80.1%) were female and 596 (47.6%) lived in institutions.

**Main outcome measures** Recent use of medical visits, nursing care at home, home-delivered meals, acute care hospital stays overnight, professional assessments such as sight tests, mobility aids and other assistive devices. A set of national healthcare system indicators was collected to help interpret differences between countries.

**Results** There was considerable variability in the healthcare services and assistive devices used by centenarians depending on their country and whether they were community-dwelling or institutionalised. In contrast to the relatively homogeneous rates of hospitalisation in the past year (around 20%), community-dwelling centenarians reported widely ranging rates of medical visits in the past 3 months (at least one visit, from 32.2% in Japan to 86.6% in France). The proportion of community-dwellers using a mobility device to get around indoors (either a walking aid or a wheelchair) ranged from 48.3% in Japan to 79.2% in Sweden. Participants living in institutions and reporting the use of a mobility device ranged from 78.6% in Japan to 98.2% in Denmark.

**Conclusions** Our findings suggest major differences in care received by centenarians across countries. Some may result from the characteristics of national healthcare systems, especially types of healthcare insurance coverage and the amounts of specific resources available. However, unexplored factors also seem to be at stake and may be partly related to personal health and cultural differences.

## INTRODUCTION

Due to declining birth rates and rising life expectancy, the segment of the world's population aged 60 years or more is the fastest

## Strengths and limitations of this study

- This is the first international investigation of healthcare services use by centenarians using a common survey questionnaire, thus enabling direct comparisons between countries with similar levels of economic development.
- We included previously unexplored fields such as the delivery of meals at home, the frequency of dental and sensory assessments and the use of assistive devices.
- Participation rates, sampling methods and interview modes varied according to settings, which may have differentially affected the representativeness of the participants in each country.
- Differences in healthcare services use by centenarians in these countries may have been due partly to variations in the involvement of informal carers—a dimension we were unable to capture.

growing.<sup>1</sup> In high-income countries, the oldest-old group (aged ≥85 years) is the most rapidly growing.<sup>2</sup> Centenarians offer a spectacular demonstration of this phenomenon: estimated to be less than half a million worldwide in 2015, they are expected to exceed 21 million in 2100.<sup>1,3</sup> Consequently, the last few decades have seen a growing number of *centenarian studies*, with diverse purposes and methods.<sup>4-6</sup>

Despite common low mortality rates and comparable economic conditions, Japan, France, Switzerland, Sweden and Denmark show varying degrees of mortality selection among their oldest-old.<sup>7</sup> It is milder in Japan, which shows the fastest increase in the number of centenarians, intermediate in France and Switzerland, and stronger in Sweden and Denmark where the rate of increase is the lowest. The *5-Country Oldest Old Project* (5-COOP) was set up to assess and

compare the sociodemographic characteristics, health status, living conditions and healthcare services use of people living in these countries who were exactly 100 years of age.<sup>7,8</sup>

The resource needs induced by population ageing challenge today's social and healthcare systems.<sup>2</sup> However, research dealing specifically with healthcare services used by centenarians remains rare and has shown heterogeneous results.<sup>9–11</sup> Moreover, international comparisons using common methods are inexistent. Lack of information prevents any anticipation of healthcare needs or the design of policies dedicated to this vulnerable population. Taking advantage of data collected by 5-COOP, the present paper aims to quantify and compare the use of healthcare services and assistive devices at the age of 100 in the five countries involved. We do not discuss potential explanatory factors such as morbidity, disability and cultural habits, nor do we consider the appropriateness of use. However, we do present comparative information on national healthcare systems, extracted from published international statistics, in order to give our results the perspective provided by shared indicators.

## METHODS

### Study design and population

5-COOP was a cross-sectional international study conducted in Japan, France, Switzerland, Sweden and Denmark. Inclusion criteria were residency (community-dwelling or institutionalised) of one of the five countries and being 100 years of age or in one's 100th year of life at enrolment. Individuals who were hospitalised when first contacted or did not speak the language of their country of residence were excluded. The intended sample size was 250 participants in each country. Between 2011 and 2014, participants were recruited via municipal lists in Japan (selected municipalities in five prefectures), regional lists in France (Languedoc-Roussillon region) and Switzerland (French-speaking region), and national lists in Sweden and Denmark. Overall, 54.5% of centenarians contacted agreed to participate, ranging from 30.6% in France to 85.6% in Sweden. The Swedish team oversampled male participants to compensate partially for the imbalanced sex ratio. One thousand two hundred fifty-three centenarians were finally included (346 in Japan, 212 in France, 170 in Switzerland, 274 in Sweden and 251 in Denmark).

### Data collection

The 5-COOP data collection protocol involved the administration of a questionnaire and, when possible, a physical examination. A common generic questionnaire containing standardised instruments was first designed in English and then translated into local languages by national investigators. Back-translation was used to ensure the quality of the process, and translated questionnaires were pretested before their use with participants. The questionnaire contained a core of compulsory questions,

supplemented by optional ones which country teams were free to include or not. Overall, investigators were able to carry out face-to-face visits in 73.3% of cases (42.9% in France, 58.8% in Sweden, 70.8% in Japan and 100% in Switzerland and Denmark). The remaining participants were contacted by telephone (14.5% of total, mostly in Japan and Sweden) or were sent a postal questionnaire (12.2% of total, mostly in France). Centenarians (either alone or assisted by a proxy) participated actively in two-thirds of all the interviews (42.5% in Japan, 59.4% in France, 62.8% in Sweden, 85.9% in Switzerland and 96.8% in Denmark), with information being provided by proxies in the remaining cases. The most frequent reason for a proxy interview was cognitive decline (36.0%), followed by hearing impairment, general weakness, altered consciousness or speech (10.5% each) and anxiety (0.8%). In 31.8% of cases, there was another reason for a proxy interview or the reason was unknown.

### Use of healthcare services and assistive devices

The present study was based on healthcare information reported in the questionnaire (corresponding sections are provided in online supplementary file 1), including the use of the following services:

- ▶ Medical visits (no specialty specified) during the previous 3 months (community-dwelling participants only);
- ▶ Nursing care at home during the previous 4 weeks (community-dwelling participants only);
- ▶ Delivery of meals at home during the previous 4 weeks (community-dwelling participants only);
- ▶ Acute care hospital stays overnight (including in an emergency room or psychiatric/psychogeriatric care) during the previous 12 months (all participants).

Use of each service was dichotomised as present or absent.

The last times which centenarians underwent a professional assessment of oral health, their eyes and vision and their hearing were dichotomised as within the previous 2 years or not (ie, longer ago or never). The last times centenarians had their blood pressure measured, their weight taken and their needs for nursing care, home help and social care evaluated was dichotomised as within the previous year or not.

Lastly, the use of a mobility device for moving around indoors and outdoors was recorded, as were the possession of glasses or contact lenses, hearing aids, dentures, bath chairs, elevated toilet seats, handles, banisters, lifting poles, medical beds and alarms.

### Statistics

This work was based on descriptive statistics. Overall and country-specific proportions are reported with their respective 95% CIs and, inspired by a recent publication by Papanicolas *et al*, ranked in decreasing order using a colour code for each country.<sup>12</sup> Stratification was applied according to place of living (community vs institution). Results from Sweden were weighted to account for the

oversampling of male participants. As some questions suffered from a relatively high occurrence of missing data, we indicate when the results were based on data from fewer than 30 respondents. A detailed table with the number of respondents for each item is provided in online supplementary file 2. The use of statistical tests was not considered relevant in this setting. Statistical analysis was performed using Stata/IC V.15.1.

### Specific characteristics of national healthcare systems

To help interpret differences between countries, we developed a list of healthcare system indicators relevant to the issues being studied and documented in most countries, including older-population demography and healthcare expenditure, financing, resources and use. The OECD Health Statistics and Health System Characteristics Survey and the UN World Population Prospects were used to ensure that national measurements were as comparable as possible. The year 2015 was chosen because it provided the most recent validated data across all countries and it was immediately after the 5-COOP data collection process. Information unavailable from these sources was obtained from national data sources when possible and relevant.

### Patient and public involvement

There was no direct participation of patients or the public in the design or conduct of this study.

## RESULTS

### Study sample

Of the 1253 participants, 1004 (80.1%) were female, ranging between 77.7% in Denmark, 82.7% in Japan, 83.5% in France and 86.5% in Switzerland. In Sweden, the crude proportion of female participants was 72.6%, corresponding to 81.9% after weighting to account for the oversampling of male participants. The proportions of participants living in institutions were comparable across countries (41.6% in Japan, 42.3% in Sweden, 44.3% in France and 45.8% in Denmark), with the notable exception of Switzerland, where this share was substantially higher (74.7%).

### Use of healthcare services

The proportion of community-dwelling participants reporting a medical visit during the previous 3 months varied markedly, from 32.2% in Japan to 86.6% in France (table 1). The use of nursing care at home was uneven across countries too, ranging from 17.6% in Japan to 57.1% in Sweden. Home-delivered meals were reported rarely in Japan (4.2%) but frequently in Denmark (62.4%).

In contrast to variations in outpatient medical and nursing care, experiences of acute care hospital stays overnight were more homogenous and were similar among community-dwelling and institutionalised participants. The proportions reporting at least one

stay in the previous year were lowest in France (13.2% in the community, 12.9% in institutions), and highest in Sweden (28.3% in the community) and Denmark (20.9% in institutions).

Recent assessments of dental and oral health were mentioned by 31.3% of community-dwelling respondents in Japan—below the 56.0% observed in Sweden. The gap was wider among institutionalised centenarians (25.8% in France to 65.9% in Sweden). Evaluations of vision and hearing showed more constant patterns: Japan exhibited the lowest values among community-dwellers (29.1% and 12.2%, respectively) and Switzerland the highest (59.5% and 50.0%). Sensory testing was less frequent among institutionalised than among community-dwelling centenarians in all countries. In contrast, blood pressure measurement and weighing during the previous year were widespread in both community-dwelling and institutionalised participants, with the notable exception of Denmark where it was only reported by a minority. Finally, fewer than half the Japanese participants mentioned a recent evaluation of nursing care, home help and social care needs (46.8% of community-dwellers and 44.9% of those institutionalised), whereas it was almost universal in Switzerland (83.7% and 100%, respectively).

### Use of assistive devices

Mobility habits differed across countries: the proportion of community-dwellers using no device or only a walking aid indoors ranged from 72.4% in Japan (16.1% in institutions) to 97.0% in Denmark (71.7% in institutions; table 2). Similarly, the share of community-dwelling respondents using no device or only a walking aid outdoors varied between 47.4% in Japan (9.8% in institutions) and 96.6% in Denmark (60.8% in institutions). More participants never went outdoors in Japan and Sweden (6.9% and 10.7% in the community, respectively, 25.0% and 19.5% in institutions), with 14.3% of institutionalised Japanese respondents even being confined to bed. The proportion of community-dwellers using a mobility device to get around indoors (either a walking aid or a wheelchair) was uneven among countries too, ranging between 48.3% in Japan and 79.2% in Sweden. Participants living in institutions and reporting the use of a mobility device ranged from 78.6% in Japan to 98.2% in Denmark. Outdoors, the share of centenarians using mobility devices was usually over 75%. There was a predominance of wheelchairs over walking aids in Japan, whereas the opposite was observed in Denmark.

Regarding other assistive devices, glasses (77.3% of all participants) and dentures (76.0%) were mentioned most frequently. Fewer than half respondents (47.0%) had hearing aids. Overall, assistive devices were more commonly used in institutions than in the community, except for glasses and hearing aids. Percentages tended to be above average in Sweden and Denmark, irrespective of place of living, and below average in Japan.

**Table 1** Reported use of healthcare services in the 5-COOP countries, by place of living

	Community-dwelling participants (n=657*)					Participants living in an institution (n=596†)						
	1	2	3	4	5	All countries	1	2	3	4	5	All countries
<b>Percentage (95% CI) of respondents reporting...</b>												
One or more medical visits during the last 3 months	France	Switzerland	Sweden	Denmark	Japan							
	86.6 (79.1 to 91.7)	77.5 (62.5 to 87.7)	49.0 (41.1 to 57.0)	48.9 (40.5 to 57.3)	32.2 (25.2 to 40.1)	54.0 (49.9 to 58.0)	n/a‡					
Nursing care at home during the last 4 weeks	Sweden	Switzerland	Denmark	France	Japan							
	57.1 (47.8 to 65.9)	53.9 (38.5 to 68.5)	44.0 (35.9 to 52.5)	39.1 (30.5 to 48.4)	17.6 (12.2 to 24.7)	39.1 (35.1 to 43.3)	n/a‡					
Home-delivered meals during the last 4 weeks	Denmark	Switzerland	Sweden	France	Japan							
	62.4 (53.9 to 70.2)	42.9 (29.1 to 57.8)	33.6 (25.9 to 42.3)	22.7 (15.9 to 31.4)	4.2 (1.9 to 8.8)	31.4 (27.6 to 35.3)	n/a‡					
One or more acute care hospital stays overnight during the last 12 months	Sweden	Denmark	Japan	Switzerland	France		Denmark	Switzerland	Sweden	Japan	France	
	28.3 (21.7 to 35.9)	19.6 (13.7 to 27.1)	15.6 (10.7 to 22.2)	14.3 (6.7 to 27.9)	13.2 (8.1 to 20.6)	18.9 (16.0 to 22.3)	20.9 (14.4 to 29.2)	19.8 (13.8 to 27.7)	18.4 (12.3 to 26.7)	17.1 (10.6 to 26.3)	12.9 (7.5 to 21.2)	18.1 (15.0 to 21.6)
<b>Percentage (95% CI) of respondents reporting a professional assessment for...</b>												
Dental and oral health in the last 2 years	Sweden	Denmark	Switzerland	France	Japan		Sweden	Switzerland	Denmark	Japan	France	
	56.0 (47.9 to 63.8)	51.1 (42.7 to 59.5)	42.9 (29.1 to 57.8)	37.3 (29.1 to 46.3)	31.3 (24.8 to 38.7)	43.4 (39.5 to 47.4)	65.9 (56.7 to 74.1)	51.2 (42.5 to 59.8)	43.9 (35.1 to 53.0)	43.4 (34.1 to 53.3)	25.8 (18.0 to 35.5)	46.6 (42.4 to 50.8)
Eye and vision in the last 2 years	Switzerland	Denmark	France	Japan	Sweden		Switzerland	Denmark	France	Japan	Sweden	
	59.5 (44.5 to 73.0)	58.5 (49.9 to 66.6)	41.5 (33.0 to 50.6)	29.1 (22.7 to 36.4)	n/a	43.5 (39.0 to 48.1)	46.4 (37.9 to 55.1)	41.9 (32.9 to 51.5)	27.7 (19.6 to 37.5)	18.2 (11.8 to 26.9)	n/a	34.5 (30.1 to 39.2)
Hearing in the last 2 years	Switzerland	Denmark	France	Japan	Sweden		Switzerland	Denmark	France	Japan	Sweden	
	50.0 (35.5 to 64.5)	48.1 (39.8 to 56.6)	28.8 (21.4 to 37.6)	12.2 (8.0 to 18.1)	n/a	30.4 (26.4 to 34.8)	46.4 (37.9 to 55.1)	36.0 (27.7 to 45.1)	23.4 (16.0 to 32.9)	9.2 (4.9 to 16.6)	n/a	30.2 (26.0 to 34.7)
Blood pressure in the last year	Switzerland	France	Japan	Denmark	Sweden		Switzerland	France	Japan	Denmark	Sweden	
	97.7 (87.9 to 99.6)	97.4 (92.7 to 99.1)	89.6 (83.9 to 93.4)	57.1 (48.6 to 65.2)	n/a	82.9 (79.2 to 86.1)	100.0 (-)	93.6 (86.8 to 97.0)	88.1 (80.4 to 93.1)	39.8 (31.3 to 49.1)	n/a	80.1 (76.1 to 83.6)
Weight in the last year	Switzerland	France	Japan	Denmark	Sweden		Switzerland	France	Japan	Denmark	Sweden	
	95.4 (84.5 to 98.7)	89.7 (82.9 to 94.0)	73.8 (66.5 to 79.9)	17.3 (11.8 to 24.6)	n/a	63.5 (58.9 to 67.7)	100.0 (-)	90.4 (82.8 to 94.9)	86.9 (78.8 to 92.2)	28.1 (20.6 to 36.9)	n/a	75.9 (71.7 to 79.7)
Nursing care, home help and social care needs in the last year	Switzerland	France	Denmark	Japan	Sweden		Switzerland	France	Denmark	Japan	Sweden	
	83.7 (70.0 to 91.9)	74.4 (58.9 to 85.4)	54.9 (46.4 to 63.1)	46.8 (39.1 to 54.6)	n/a	56.9 (51.8 to 61.8)	100.0 (-)	67.5 (62.0 to 79.9)	56.2 (46.6 to 65.3)	44.9 (35.0 to 55.3)	n/a	69.8 (64.9 to 74.4)

Results for Sweden and all countries are weighted to account for the oversampling of Swedish male participants.

\*Number of community-dwelling participants by country: Japan 202, France 118, Switzerland 43, Sweden 158, Denmark 136.

†Number of institutionalised participants by country: Japan 144, France 94, Switzerland 127, Sweden 116, Denmark 115.

‡Outcomes measured among community-dwelling participants only.

§5-COOP: 5-Country Oldest Old Project; n/a, not available.

**Table 2** Reported use of assistive devices in the 5-COOP countries, by place of living

	Community-dwelling participants (n=657*)					Participants living in an institution (n=596†)						
	1	2	3	4	5	All countries	1	2	3	4	5	All countries
<b>Percentage (95% CI) of respondents using a mobility device to get around indoors</b>												
No device	Japan 45.4 (38.2 to 52.8)	France 42.1 (33.4 to 51.3)	Denmark 32.6 (25.2 to 41.0)	Switzerland 29.0 (16.1 to 46.6)	Sweden 19.7 (14.2 to 26.6)	35.1 (31.4 to 39.0)	France 17.7 (11.0 to 27.1)	Japan 7.1 (3.7 to 13.5)	Switzerland 6.7 (3.3 to 13.1)	Sweden 6.1 (2.9 to 12.2)	Denmark 1.8 (0.5 to 6.2)	7.4 (5.4 to 10.0)
Cane(s), quadripod(s), crutch(es) or walker	Sweden 65.2 (57.2 to 72.4)	Denmark 64.4 (55.9 to 72.1)	Switzerland 61.3 (43.8 to 76.3)	France 42.1 (33.4 to 51.3)	Japan 27.0 (21.0 to 34.1)	49.0 (45.0 to 53.0)	Denmark 69.9 (60.9 to 77.6)	Switzerland 47.6 (38.3 to 57.1)	Sweden 46.5 (37.4 to 55.9)	France 30.6 (21.8 to 41.1)	Japan 8.9 (4.9 to 15.7)	41.1 (37.0 to 45.4)
Wheelchair	Japan 21.3 (15.8 to 27.9)	France 15.8 (10.2 to 23.6)	Sweden 14.0 (9.2 to 20.7)	Switzerland 9.7 (3.3 to 24.9)	Denmark 3.0 (1.2 to 7.5)	13.8 (11.3 to 16.8)	Japan 69.6 (60.6 to 77.4)	France 51.8 (41.3 to 62.1)	Switzerland 45.7 (36.5 to 55.2)	Sweden 45.4 (36.4 to 54.8)	Denmark 28.3 (20.8 to 37.2)	48.0 (43.8 to 52.3)
Bedridden	Japan 6.3 (3.6 to 11.0)	Sweden 1.2 (0.3 to 4.4)	France 0.0 (-)	Switzerland 0.0 (-)	Denmark 0.0 (-)	2.2 (1.3 to 3.7)	Japan 14.3 (9.0 to 22.0)	Sweden 2.0 (0.5 to 6.9)	France 0.0 (-)	Switzerland 0.0 (-)	Denmark 0.0 (-)	3.5 (2.2 to 5.4)
<b>Percentage (95% CI) of respondents using a mobility device when going outdoors</b>												
No device	France 23.7 (16.2 to 33.2)	Denmark 16.1 (10.6 to 23.8)	Japan 15.0 (10.5 to 21.1)	Switzerland 11.1 (3.8 to 28.1)	Sweden 5.9 (3.2 to 10.8)	14.3 (11.6 to 17.5)	France 11.6 (6.0 to 21.3)	Switzerland 7.2 (3.4 to 14.9)	Sweden 1.5 (0.4 to 5.6)	Denmark 1.0 (0.2 to 5.6)	Japan 0.9 (0.2 to 4.9)	3.8 (2.4 to 5.9)
Cane(s), quadripod(s), crutch(es) or walker	Denmark 80.5 (72.4 to 86.7)	Switzerland 77.8 (59.2 to 89.4)	France 65.6 (55.5 to 74.5)	Sweden 60.5 (52.3 to 68.1)	Japan 32.4 (25.8 to 39.7)	57.6 (53.5 to 61.7)	Denmark 59.8 (49.8 to 69.0)	Switzerland 43.4 (33.2 to 54.1)	Sweden 32.7 (24.7 to 41.8)	France 30.4 (20.8 to 42.1)	Japan 8.9 (4.9 to 15.7)	34.2 (30.0 to 38.6)
Wheelchair	Japan 45.7 (38.4 to 53.1)	Sweden 22.9 (16.7 to 30.4)	France 11.1 (3.8 to 28.1)	Switzerland 10.8 (5.9 to 18.7)	Denmark 3.4 (1.3 to 8.4)	23.2 (19.9 to 26.9)	Japan 65.2 (56.0 to 73.4)	France 58.0 (46.2 to 68.9)	Switzerland 49.4 (38.9 to 60.0)	Sweden 46.3 (37.3 to 55.6)	Denmark 39.2 (30.0 to 49.1)	51.6 (47.1 to 56.1)
Never going outdoors	Sweden 10.7 (6.7 to 16.9)	Japan 6.9 (4.0 to 11.7)	France 0.0 (-)	Switzerland 0.0 (-)	Denmark 0.0 (-)	4.8 (3.4 to 6.9)	Japan 25.0 (17.9 to 33.8)	Sweden 19.5 (13.2 to 27.9)	France 0.0 (-)	Switzerland 0.0 (-)	Denmark 0.0 (-)	10.4 (8.0 to 13.5)
<b>Percentage (95% CI) of respondents having...</b>												
Glasses or contact lenses	France 92.3 (86.0 to 95.9)	Switzerland 87.1 (71.1 to 94.9)	Sweden 86.2 (79.3 to 91.1)	Denmark 82.8 (75.5 to 88.3)	Japan 74.3 (67.3 to 80.2)	83.1 (79.8 to 85.9)	Sweden 83.8 (76.0 to 89.4)	France 78.4 (68.7 to 85.7)	Denmark 72.2 (63.4 to 79.6)	Switzerland 68.2 (59.0 to 76.2)	Japan 52.4 (42.9 to 61.8)	70.8 (66.8 to 74.5)
Hearing aids	Switzerland 67.7 (50.1 to 81.4)	Denmark 64.4 (56.1 to 72.0)	Sweden 54.2 (46.2 to 62.0)	France 43.1 (34.4 to 52.2)	Japan 31.8 (25.2 to 39.1)	48.6 (44.6 to 52.6)	Denmark 63.5 (54.4 to 71.7)	Switzerland 55.5 (46.2 to 64.4)	Sweden 44.6 (35.6 to 53.9)	France 38.6 (29.1 to 49.1)	Japan 20.4 (13.7 to 29.2)	45.1 (40.9 to 49.4)
Dentures (partial or total)	Japan 87.1 (81.3 to 91.4)	France 83.6 (75.8 to 89.3)	Sweden 74.2 (56.7 to 86.3)	Switzerland 73.1 (65.0 to 79.9)	Denmark 57.2 (49.1 to 64.8)	75.6 (72.0 to 78.9)	Denmark 84.2 (76.4 to 89.8)	Switzerland 78.2 (69.6 to 84.9)	Japan 77.7 (68.7 to 84.6)	France 75.0 (65.0 to 82.9)	Sweden 66.0 (56.6 to 74.2)	76.5 (72.7 to 79.9)
A bath chair	Sweden 72.7 (64.4 to 79.6)	Denmark 65.4 (57.0 to 73.0)	Switzerland 45.2 (29.1 to 62.3)	Japan 41.5 (34.1 to 49.3)	France 39.7 (31.2 to 48.8)	53.7 (49.5 to 57.7)	Sweden 91.4 (84.7 to 95.3)	Denmark 91.3 (84.7 to 95.2)	Switzerland 81.8 (73.6 to 87.9)	France 59.3 (48.7 to 69.1)	Japan 36.3 (27.1 to 46.5)	73.9 (69.9 to 77.5)

Continued

Table 2 Continued

	Community-dwelling participants (n=657*)					Participants living in an institution (n=596†)						
	1	2	3	4	5	All countries	1	2	3	4	5	All countries
An elevated toilet seat	Sweden 68.7 (60.3 to 75.9)	Denmark 41.8 (33.8 to 50.3)	Switzerland 35.5 (21.1 to 53.1)	France 32.8 (24.9 to 41.7)	Japan 12.5 (8.1 to 18.7)	37.3 (33.4 to 41.4)	Sweden 82.7 (74.5 to 88.7)	Denmark 68.1 (59.1 to 76.0)	Switzerland 50.9 (41.7 to 60.1)	France 44.7 (34.6 to 55.3)	Japan 8.2 (4.0 to 16.1)	53.1 (48.7 to 57.4)
A handle	Denmark 55.6 (47.1 to 63.7)	Switzerland 45.2 (29.1 to 62.3)	Sweden 45.2 (36.9 to 53.7)	France 33.6 (25.7 to 42.6)	Japan 15.3 (10.5 to 21.7)	36.9 (33.0 to 40.9)	Sweden 71.0 (61.9 to 78.7)	Switzerland 66.4 (57.1 to 74.5)	France 61.6 (51.0 to 71.2)	Denmark 55.3 (46.1 to 64.1)	Japan 26.3 (17.8 to 36.8)	57.5 (53.1 to 61.7)
A bannister	Japan 68.5 (61.0 to 75.1)	Denmark 42.9 (34.8 to 51.4)	France 33.0 (25.1 to 42.1)	Switzerland 19.4 (9.2 to 36.3)	Sweden 10.3 (6.1 to 16.8)	40.2 (36.2 to 44.3)	Denmark 89.5 (82.5 to 93.9)	Switzerland 70.9 (61.8 to 78.6)	Japan 65.9 (55.7 to 74.9)	France 64.0 (53.4 to 73.3)	Sweden 32.3 (24.3 to 41.6)	65.2 (61.0 to 69.2)
A lifting pole	France 20.7 (14.3 to 29.0)	Japan 19.5 (14.0 to 26.5)	Sweden 18.3 (12.6 to 25.9)	Denmark 16.5 (11.2 to 23.8)	Switzerland 12.9 (5.1 to 28.9)	18.4 (15.4 to 21.8)	Sweden 92.2 (85.7 to 95.9)	Switzerland 90.9 (84.1 to 95.0)	France 41.4 (31.6 to 51.9)	Denmark 24.6 (17.6 to 33.2)	Japan 18.3 (11.4 to 28.0)	55.4 (51.0 to 59.7)
A medical bed	Japan 45.7 (38.4 to 53.1)	France 32.5 (24.5 to 41.5)	Denmark 30.4 (23.2 to 38.6)	Switzerland‡ 27.3 (13.1 to 48.2)	Sweden n/a	36.7 (32.4 to 41.3)	Switzerland 98.2 (93.5 to 99.5)	Denmark 93.9 (87.9 to 97.0)	France 81.1 (71.8 to 87.9)	Japan 77.7 (68.7 to 84.6)	Sweden n/a	88.2 (84.8 to 91.0)
An alarm	Sweden 90.7 (84.8 to 94.5)	Denmark 69.4 (61.1 to 76.6)	Switzerland 54.8 (37.7 to 70.9)	France 31.9 (24.1 to 40.9)	Japan 17.2 (12.2 to 23.7)	50.3 (46.2 to 54.4)	Denmark 91.3 (84.7 to 95.2)	Sweden 88.5 (81.1 to 93.2)	France 78.4 (68.7 to 85.7)	Switzerland 73.6 (64.7 to 81.0)	Japan 66.0 (55.9 to 74.8)	80.0 (76.3 to 83.3)

Results for Sweden and all countries are weighted to account for oversampling of Swedish male participants.

\*Number of community-dwelling participants by country: Japan 202, France 118, Switzerland 43, Sweden 158, Denmark 136.

†Number of institutionalised participants by country: Japan 144, France 94, Switzerland 127, Sweden 116, Denmark 115.

‡Fewer than 30 respondents.

§5-COOP, 5-Country Oldest Old Project; n/a, not available.

### Specific characteristics of national healthcare systems

In 2015, centenarians were more than twice as common in Japan (45.5 per 100 000 population) than in Switzerland, Sweden or Denmark (19.6, 19.1 and 20.0 per 100 000, respectively), with France lying in between (31.0 per 100 000; [table 3](#)). Variation in the share of gross domestic product (GDP) devoted to healthcare was limited (from 10.3% in Denmark to 11.9% in Switzerland), but the proportion of total healthcare expenditure dedicated to long-term care differed from 14.9% in France to 26.2% in Sweden.

In terms of healthcare resources, the number of practising physicians ranged from 2.4 per 1000 population in Japan to 4.2 per 1000 in Sweden. Acute care hospital capacity showed the opposite trend with 2.3 beds per 1000 population in Sweden and 7.9 per 1000 in Japan, with the latter exhibiting an average length of stay almost three times that of other countries (16.5 vs 5.7 days). Regarding hospital use, Japan had the lowest rate of inpatient care discharges for the overall population (124.1 per 1000), and France had the highest (181.9 per 1000). This was in contradiction to the discharge rate observed for people aged  $\geq 80$  years, which was lowest in France (419.0 per 1000) and highest in Sweden (638.5 per 1000).

According to national statistics, elders were more likely to receive long-term care at home in Switzerland (15.7% of people aged  $\geq 65$  years), even though more staff were devoted to home care in Japan (4.5 workers per 100 population aged  $\geq 65$  years vs 2.8 per 100 in Switzerland). In institutions, the opposite was true, with greater human resources in Switzerland (5.3 workers per 100 population aged  $\geq 65$  years) than in Japan (1.4 per 100). The number of beds in residential long-term care facilities was also highest in Switzerland (65.9 per 1000 population aged  $\geq 65$  years) and lowest in Japan (24.3 per 1000), as was the proportion of the elder population living in institutions (5.9% in Switzerland and 2.7% in Japan).

## DISCUSSION

### Principal findings

There was significant geographical variability with regard to the use of healthcare services and assistive devices by centenarians, and this also differed according to their place of living (in an institution or in the community). Even though all five countries dedicated comparable shares of GDP to healthcare, their healthcare resources and use varied, as recently highlighted in a study comparing the healthcare systems of high-income countries, including those involved in 5-COOP.<sup>12</sup>

### Analysis and comparison with other studies

Apart from in Switzerland, the share of institutionalised centenarians in our sample agreed with the findings of several studies (from 42.1% in Portugal to 53.7% in Canada).<sup>9 10 13 14</sup> However, other works disclosed proportions above 60%, and a study based on European census data revealed considerable geographical variations, with

percentages ranging from 10% to 90%.<sup>6 15 16</sup> The Swiss exception observed in 5-COOP is consistent with its more substantial proportion of elders living in institutions, as reported in OECD statistics, and matches the greater numbers of staff and long-term care beds found there. Moreover, this is supported by the findings of recent research disclosing a high prevalence (27.9%) of nursing home admissions in elders' last years of life in Switzerland.<sup>17</sup> Institutionalisation did not seem to act as a substitute for home care, whose use was also more frequent in Switzerland, nor was it related to the proportion of total healthcare expenditure dedicated to long-term care.

The number of medical visits seemed to match differences in the number of general practitioners in each country, but the relationship was less noticeable when taking all practising physicians together. In other studies addressing the topic,  $>95\%$  of centenarians had seen a doctor during the previous 12 months.<sup>9 10 15</sup> Regarding nursing care at home, its more frequent use in Switzerland and Sweden was comparable to that reported in Germany (52.8%) and Canada (55.9%), whereas its use in France and Denmark was closer to that recently found in Portugal (44.4%).<sup>9 10 13</sup> Japan distinguished itself by more limited use of nursing care at home. Our observations agreed with the higher shares of elderly populations who received home care in Switzerland and Sweden, but they appear paradoxical in light of greater staff resources devoted to home care in Japan. However, this could be skewed by the double-counting of Japanese workers who have two or more employers in the OECD statistics.<sup>18</sup> The characteristics of healthcare systems do not explain divergent national practices regarding home-delivered meals, perhaps because this service is often provided by welfare services instead, as in Japan.<sup>19</sup> Moreover, in Japan, meal preparation can also be part of the duties of paid home helpers. Disparities exist within countries too, as in Sweden, where municipalities are responsible for organising meals-on-wheels and pursue varying policies.<sup>20</sup> In contrast, centenarians' experiences of acute care hospital stays overnight differed little between countries and were similar to other observations made in Europe, Canada and Australia (ranging from 10.9% to 22.1%).<sup>6 10 14 15</sup> Studies conducted in England and the USA have revealed annual hospital admission rates for centenarians superior to 50%, suggesting that all the 5-COOP countries had low hospitalisation rates by international standards.<sup>21 22</sup> It should be noted, however, that hospitalised centenarians were excluded by the 5-COOP investigators, which could have led to an underestimation of hospitalisation rates. Our results did not match differences in the number of hospital beds available in the participating countries. Interestingly though, our observations seem to evolve in parallel with the discharge rates for the population aged  $\geq 80$  years but not with that of the general population, possibly revealing differing practices concerning the hospitalisation of the oldest-old.

Our results confirmed the limited access elders have to dental care and its variability from one country to

**Table 3** Demographic and healthcare system indicators in the 5-COOP study participating countries

	Japan	France	Switzerland	Sweden	Denmark	Year	Source
<b>Demographic characteristics</b>							
Proportion of country population aged ≥65 years, %	26.0	18.9	18.0	19.6	19.0	2015	1
Number aged ≥100 years, per 100 000 population	45.5	31.0	19.6	19.1	20.0	2015	1
Number aged ≥100 years, per 100 000 population aged ≥65 years	174.9	163.8	108.8	97.7	105.2	2015	1
<b>Healthcare expenditure and financing</b>							
Total healthcare expenditure as a share of gross domestic product, %	10.9	11.5	11.9	11.0	10.3	2015	2
Main financial source of basic care coverage: tax-based national healthcare system (NHS); multiple insurance schemes with automatic affiliation and wage-dependent contribution (statutory); universally mandated private insurance with free choice of insurer and community-rated premiums (mandatory)	Statutory	Statutory	Mandatory	NHS	NHS		3
Share of total healthcare expenditure financed by household out-of-pocket payments, %	12.9	9.8	29.1	15.5	13.8	2015	2
Share of total healthcare expenditure devoted to long-term care, %	18.3	14.9	19.5	26.2	24.5	2015	2
Share of long-term care expenditure financed by household out-of-pocket payments, %	7.2	22.4	32.8	7.3	8.3	2015	2
Participation of the main financial source of basic care coverage to the costs of dental care	Co-payment of 30%	Coinsurance of 30%	Not covered*	Deductible + coinsurance of 50%	Not covered*		3
<b>Healthcare resources and use</b>							
Practising physicians, per 1000 population	2.4	3.1	4.1	4.2	3.7	2014	2
General practitioners, per 1000 population	n/a	1.5	1.2	0.6	0.7	2015	2
Practising dentists, per 1000 population	0.79	0.64	0.51	0.80	0.75	2014	2
Acute care hospital beds, per 1000 population	7.9	3.2	3.7	2.3	2.5	2015	2
Curative care, average length of stay, days	16.5	5.7	5.7	5.7	n/a	2015	2
Inpatient care discharges (all hospitals and types of care), per 1000 population (total)	124.1	181.9	171.5	153.2	147.8	2015	2
Inpatient care discharges (all hospitals and types of care), per 1000 population aged ≥80 years	n/a	419.0	548.2	638.5	n/a	2015	4
<b>Long-term care resources and use</b>							
Long-term care workers (total), per 100 population aged ≥65 years	5.9	n/a	8.0	12.4	8.1	2015	2
Long-term home care workers, per 100 population aged ≥65 years	4.5	n/a	2.8	n/a	3.2	2015	2
Long-term institutional care workers, per 100 population aged ≥65 years	1.4	1.9	5.3	n/a	5.0	2014	2
Beds in residential long-term care facilities, per 1000 population aged ≥65 years	24.3	53.1	65.9	65.5	48.7†	2015	2
Proportion of population aged ≥65 years receiving long-term care at home, %	n/a	6.1	15.7	12.5	11.6‡	2015	2
Proportion of population aged ≥65 years receiving long-term care in institutions, %	2.7	4.2	5.9	4.5	3.9§	2015	2

Sources: (1) UN World Population Prospects: The 2017 Revision (available from <https://population.un.org/wpp/>), (2) OECD Health Statistics 2018 (available from <https://stats.oecd.org/>), (3) OECD Health System Characteristics Survey 2016 (available from <http://qdd.oecd.org/subject.aspx?Subject=hsc>), (4) France: Technical Agency for Information on Hospital Care; Switzerland: Federal Statistical Office; Sweden: National Board of Health and Welfare.

\*With exceptions for specific conditions.

†2011 data.

‡2012 data.

§2014 data.

5-COOP, 5-Country Oldest Old Project; n/a, not available.



another (previously underscored by WHO) despite the well-recognised importance of oral health for quality of life and health status.<sup>23 24</sup> Interestingly, insurance coverage for dental costs did not seem to have an influence, nor did the density of dentists. The share of participants reporting a sensory assessment was even lower than that observed for oral health, despite the widespread prevalence of vision and hearing deficiencies among centenarians and the negative impact they have on well-being.<sup>25–27</sup> The contrast was striking in comparison to blood pressure and weight monitoring, which was almost generalised, even though its positive impact on quality of life is less obvious. Regarding assessments of nursing care, home help and social care needs, the higher numbers observed among community-dwellers in France and Switzerland could be related to those countries' wider use of medical visits and, in the case of Switzerland, of nursing care at home, both interventions being conducive to such assessments. However, given the evidence supporting the benefits of comprehensive assessments for elders, notably in terms of daily functioning, the variety of practices is surprising.<sup>28</sup> In Swiss nursing homes, these evaluations fall under the healthcare reimbursement system, which explains their systematic use.

Few studies have addressed centenarians' use of assistive devices, and their results showed various tendencies, whether with mobility aids or other devices.<sup>13 14 29 30</sup> Although we were unable to draw any conclusions from the present study's settings, differences in the use of mobility aids could be related to differences in centenarians' functional limitations and influenced by cultural contexts too. Interestingly, in recent research based on the same study population, the prevalence of falls in Japan, which had the highest proportion of bedridden or wheelchair-using centenarians, was about half that of the other countries.<sup>31</sup> However, it is known that socioeconomic aspects play a significant part too, and the common use of mobility devices in Sweden and Denmark could be related to them being heavily subsidised by the tax-based national healthcare system; higher out-of-pocket expenses may limit their acquisition in other countries.<sup>32 33</sup> Having glasses did not match the frequency of the vision assessments discussed earlier. On the contrary, countries providing more hearing evaluations showed broader hearing aid use, indicating that the limited access to such devices could be partly related to underdiagnosis. Interestingly, there seemed to be an inverse relationship between the frequency of dental assessments and the possession of dentures. It is open to debate whether limited access to dental care results in poor dentition and the use of dentures, or whether centenarians who still have their natural teeth are more likely to visit an oral health professional. As with mobility aids, the high frequency of use of devices such as hearing aids in Sweden and Denmark could result partly from more generous insurance coverage by their national healthcare systems.

### Study strengths and weaknesses

The large sample of centenarians surveyed was a strength of the 5-COOP study and it was the first international investigation of healthcare services used by centenarians using a common survey questionnaire, thus permitting direct comparisons between countries at similar levels of economic development. Moreover, we were able to explore new fields, such as the delivery of meals-on-wheels and the frequency of dental and sensory assessments, as well as the use of assistive devices, never before considered.

However, several limitations need to be acknowledged too. First, the varied participation rates, sampling methods and interview modes used could have differentially affected the representativeness of the participants in each country, hence biasing comparisons. We also cannot exclude that healthier centenarians were more prone to participate in the study, resulting in biased estimations. Participation by proxies should have limited this possibility. Unfortunately, the available data did not allow us to assess the reliability of proxy interviews. Second, the methodology used in collecting OECD statistics is also subject to local specificities, which could jeopardise the comparability of indicators across nations. Third, differences in the use of healthcare services between countries may be partly explained by variations in the involvement of informal caregivers, a dimension which our indicators were unable to capture. In the same vein, differences in centenarians' health status could have contributed to variable use patterns, as suggested by the uneven prevalence of the frailty phenotype recently shown in another 5-COOP paper.<sup>8</sup> However, health status and care habits are sometimes difficult to disentangle, and differences in use did not show any systematic patterns or match the prevalence of frailty. This suggests that if such a difference in health status existed, it would not account for all of the heterogeneity observed in the use of healthcare services and assistive devices.

### CONCLUSIONS

Despite living in countries with comparable economic conditions and healthcare spending, the centenarians participating in the 5-COOP study reported varying use of healthcare services and assistive devices. Although causality remains to be established, some of these differences could be related to the characteristics of national healthcare systems, especially the type of healthcare insurance coverage and the amount of specific resources allotted to healthcare. However, unexplored factors may also be at work. Cultural differences, as in the role of informal caregivers, for example, could be significant. Our results revealed differing models of care, but whether one of those models is better suited to improving centenarians' health outcomes and quality of life remains an open question.

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**Contributors** JD did the statistical analyses and drafted the manuscript. JD and BS-E designed the article and contributed to the interpretation of data. JD, KA-R, SF, MH and TW collected national healthcare system indicators. FRH gathered and prepared 5-COOP data for analysis. KA-R, SF, MH, FRH, BJ, J-MR, YS, BS-E and the other members of the 5-COOP group contributed to the conception of the survey questionnaire. KA-R, SF, MH, FRH, BJ, J-MR, YS and the other members of the 5-COOP group participated in planning of the 5-COOP study and collection of data. All authors commented on drafts, read and approved the final manuscript. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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