



ORIGINAL ARTICLE

# A comparison of health expectancies over 10 years: implications for elderly service needs in Hong Kong

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## Abstract

**Objectives** We aimed to estimate health expectancies at age 65 based on physical and cognitive function in 2001–2002 and 2011–2012 and project future needs for carers from 2021 to 2041.

**Methods** Data from the Elderly Health Centres (EHCs) of the Department of Health of the Government of Hong Kong comprising of people aged 65 years or older who enrolled between 2001 and 2002 (EHC 2001–2002) and between 2011 and 2012 (EHC 2011–2012) provided proportion estimates for physical impairment (assessed by independence in activities of daily living) and cognitive impairment (assessed by Abbreviated Mental Test/Mini-Mental Status Examination and self-reported doctor diagnosis of dementia). Health expectancies (years lived with/without physical and/or cognitive impairment) were calculated by Sullivan's method. The proportions of physical and/or cognitive impairment were used to project future needs for carers.

**Results** Between 2001–2002 and 2011–2012, years lived without physical/cognitive impairment decreased for men but increased for women, both of which were less than the increases in total life expectancy. Men assessed in 2011–2012 (classified as EHC 2011–2012) lived more years with physical and/or cognitive impairment than those assessed in 2001–2002 (classified as EHC 2001–2002), and women in EHC 2011–2012 lived more years with physical impairment, but fewer years with cognitive impairment than those in EHC 2001–2002, and women enrolled in EHC 2011–2012 lived more years with physical impairment, but fewer years with cognitive impairment than those in EHC 2001–2002. As populations age, the number of carers needed is expected to increase from 344,000 in 2021 to 629,000 by 2041, or an increase of 82.9%. Sensitivity analyses excluding the participants who had been assessed in 2011–2012 from EHC 2001–2002 gave similar estimations.

**Conclusions** Increased life expectancy was not accompanied by an increase in years lived without physical/cognitive impairment. These findings suggest that people will live longer but could be more dependent, which would have considerable implications for elderly service needs in Hong Kong.

**Keywords** Life expectancy · Healthy life expectancy · Physical impairment · Cognitive impairment · Elderly services · Health expectancy

## Introduction

Population ageing is one of the major challenges that most countries in the world are facing and Hong Kong is no exception. Compared to other countries, Hong Kong has topped the world charts for longevity, with men expected to live to 81.3 years, while women are expected to live to 87.3 years in 2016. With the rise of life expectancy in Hong Kong, as with elsewhere, there is a need to capture the quantity as well as the quality of the years lived.

Several countries have been estimating the healthy expectancies of their own population over time aiming

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to deliver appropriate services in response to the changes in population health status (Lubitz et al. 2003; Australian Institute of Health and Welfare 2014). The Global Burden of Disease Study 2016 (GBD 2016) provided healthy life expectancy estimates for 195 countries and territories between 1990 and 2016 and reported that, at a global level, healthy life expectancy continued to show improvements, but at the same time, many populations were facing growing functional health loss (GBD 2016 DALYs and HALE Collaborators 2017).

Health expectancies are most often determined by mortality and health burden primarily based on the capacity to perform Activities of Daily Living (ADL). Nevertheless, projections of health burden based on ADL may not be precise, as it reflects not only health status, but also the availability of facilities to assist such activities. Alternatively, some studies included self-rated health in the estimations of health expectancies (Gu et al. 2009; Lagergren et al. 2016) as self-rated health may be more likely to tap into psychological health. However, concern has arisen that self-rated health may not correspond to objective health in the same way for different socioeconomic status groups (Dowd and Zajacova 2010).

Cognitive impairment-free life expectancy has also been estimated in different populations (Suthers et al. 2003; Ashby-Mitchell et al. 2015; Jagger et al. 2016). A number of studies have also reported increasing trends in cognitive impairment or dementia (Ahmadi-Abhari and Guzman-Castillo 2017; Zeng et al. 2017), although there was a downward trend in the prevalence of cognitive impairment from 1993 to 2004 in older Americans (Sheffield and Peek 2011). Recently, analyses from the Cognitive Function and Ageing Study (CFAS) estimated the number of years lived in different dependency states at age 65 years based on activity limitation, incontinence and dementia, which is likely to enhance the accuracy of projections of needs of care (Kingston et al. 2017).

Although life expectancy has been increasing steadily in Hong Kong, a previous local study revealed that an expansion of morbidity occurred between 1996 and 2008, where chronic morbidity-free life expectancy decreased substantially during this period (Cheung and Yip 2010). These results are consistent with those of other local studies showing increasing trends in ADL disability between 2001 and 2012 (Yu et al. 2016) and dementia between 2001 and 2009 (Yu et al. 2012), suggesting that Hong Kong appears to be experiencing continued decline in health expectancy. Routinely monitoring the trends of health expectancies is a crucial input to guide the elderly services planning of Hong Kong. In this study, we estimated health expectancies at age 65 based on physical and cognitive function in 2001–2002 and 2011–2012 and projected future needs for carers from 2021 to 2041.

## Methods

### Study design and participants

We used data from the 18 Elderly Health Centres (EHCs) of the Department of Health, which has been collecting longitudinal health data from a large population-based cohort in Hong Kong since 1998. All residents of Hong Kong aged 65 years or older can voluntarily enrol. Enrollees in the cohort receive standard medical examinations at baseline and are reassessed in subsequent years. The details of this cohort have been described elsewhere (Schooling et al. 2016). In this study, we retrieved cross-sectional data ( $n = 119,190$ ) from the EHCs of individuals who enrolled between 2001 and 2002 (classified as EHC 2001–2002,  $n = 56,687$ ) and between 2011 and 2012 (classified as EHC 2011–2012,  $n = 62,503$ ), and excluded those who were institutionalized ( $n = 2656$ ). Participants in EHC 2011–2012 who had been assessed in 2001–2002 were further excluded ( $n = 22,321$ ). Therefore, 94,213 participants remained in the analysis. All participants gave written consent and the study has been approved by the ethics committee of the Department of Health of the Government of the Hong Kong Special Administrative Region.

### Data collection

#### Assessment of physical impairment

A modified version of the Katz Index of Independence in ADL was used to measure functional impairment (Katz et al. 1963). Participants reported whether they needed (1) no help, (2) help, or (3) were unable to do five of the six activities in the Katz ADL including bathing, dressing, toileting, transferring from a bed to a chair, and feeding. Incontinence was not included because it may be present in individuals who otherwise displayed no disability. Two additional activities, used by Branch et al., were also assessed: grooming and ability to walk across a small room (Branch et al. 1984). The number of activities that participants reported as needing help or being unable to perform was calculated for each evaluation. Total possible scores of the ADL scale range from 7 to 21. Physical impairment was defined as being unable to perform at least one of seven ADL activities independently (i.e. a score  $> 7$  indicates physical impairment).

#### Assessment of cognitive impairment (including dementia)

Cognitive impairment (including dementia) was defined based on the results of the Abbreviated Mental Test (Hong Kong version), AMT (for EHC 2001–2002), the Cantonese

Mini-Mental Status Examination, CMMSE (for EHC 2011–2012), and self-reported doctor diagnosis of dementia (for both EHC 2001–2002 and EHC 2011–2012). AMT is a brief, ten-item scale used to screen for cognitive impairment (Hodkinson 1972). The validated Hong Kong version was adopted (Chu et al. 1995). A score of < 8 was used to define cognitive impairment (Jitapunkul et al. 1991). CMMSE is a validated Cantonese version of Mini-Mental Status Examination (Folstein et al. 1975; Chiu et al. 1994). In the present study, arbitrary scores of < 21 for illiterate, < 24 for those who had primary school level, and < 27 for those who had secondary school level or above were used to define cognitive impairment.

### Covariates

Covariates included age, period, marital status, educational attainments, chronic disabling diseases, and hearing and eyesight problems.

### Statistical analysis

The age- and sex-specific proportion estimates of each type of impairment were calculated for EHC 2001–2002 and EHC 2011–2012; both of which were standardized to the Hong Kong population in 2011, according to sex and 5-year age band. The comparisons between the two EHC cohorts were performed by t-tests for continuous variables or chi-squared tests for categorical variables. Ordinal logistic regression models of physical and cognitive status were fitted for each sex. Models were initially adjusted for age (5-year age band), period (0 = EHC 2001–2002, 1 = EHC 2011–2012), and then additionally adjusted for marital status, educational attainments, chronic disabling diseases, and hearing and eyesight problems. Adjusted proportions of participants with different types of impairment were estimated from the models. Life expectancies without impairment, with physical impairment, with cognitive impairment, and with both types of impairment for each period (2001–2002, 2011–2012) were calculated by Sullivan's method. To project future needs for carers from

**Table 1** Socio-demographic characteristics of participants of Elderly Health Centres in Hong Kong, 2001–2002 and 2011–2012

	EHC 2001–2002 ( <i>N</i> = 54,790)	EHC 2011–2012 ( <i>N</i> = 39,423)	<i>P</i> value
Age (years)	72.66 (5.21)	73.93 (5.13)	< 0.0001
	Range (65–100)	Range (65–99)	
Age group (years)			
65–69	17,993 (32.84%)	8403 (21.31%)	< 0.0001
70–74	19,368 (35.35%)	14,813 (37.57%)	
75–79	11,314 (20.65%)	10,605 (26.9%)	
80–84	4567 (8.34%)	4221 (10.71%)	
85+	1548 (2.83%)	1381 (3.5%)	
Sex			
Men	19,594 (35.76%)	14,065 (35.68%)	0.7886
Women	35,196 (64.24%)	25,358 (64.32%)	
Education <sup>a</sup>			
Illiterate	14,125 (25.78%)	6728 (17.07%)	< 0.0001
Some primary	9004 (16.43%)	3495 (8.87%)	
Primary	21,111 (38.53%)	14,946 (37.92%)	
Secondary	8269 (15.09%)	9880 (25.07%)	
College or university	2279 (4.16%)	4365 (11.07%)	
Marital status <sup>a</sup>			
Single	1510 (2.76%)	900 (2.28%)	< 0.0001
Married or cohabiting	33,457 (61.1%)	25,970 (65.88%)	
Widowed	18,507 (33.8%)	11,253 (28.55%)	
Separated or divorced	1281 (2.34%)	1295 (3.29%)	

Data are *n* (%) and un-weighted

EHC Elderly Health Centre

<sup>a</sup>The number of participants does not add up to *N* for the two cohorts because of missing values in these variables. These percentages are proportions of the non-missing values

2021 to 2041, we assumed that the proportion of people aged 65 years or older with each type of impairment remains constant as of EHC 2011–2012. Implications on carer needs were estimated in terms of carers' time (Woo and Chau 2009). Sensitivity analyses were performed to examine how a further exclusion of the participants who had been assessed in 2011–2012 from the EHC 2001–2002 ( $n = 22,516$ ) changes the estimates. Analyses were carried out using the SAS statistical package v9.4 (SAS Institute, Inc, Cary, NC), and  $p$  values less than 0.05 were considered statistically significant.

## Results

Compared with those in EHC 2001–2002, participants in EHC 2011–2012 were older ( $p < 0.0001$ ), had higher education level ( $p < 0.0001$ ), and were more likely to be married ( $p < 0.0001$ ) (Table 1). Furthermore, a higher proportion of participants with physical and/or cognitive impairment was observed in EHC 2011–2012 (Table 2). After adjustment for age, period, marital status, levels of education, chronic disabling diseases, and hearing and eyesight problems, the proportions of each type of impairment increased significantly for men between 2001–2002 and 2011–2012 for all age groups. For women, the proportions for physical impairment and both types of impairment increased significantly between 2001–2002 and 2011–2012 for all age groups. However, the proportions for cognitive impairment were lower in EHC 2011–2012 for all age groups (Table 3).

In 2001, life expectancy for men aged 65 was 17.2 years of which 16.7 years (96.8% of their remaining life) was spent without physical/cognitive impairment. Women aged 65 lived longer with a life expectancy of 20.2 years but spent a lower proportion of impairment-free years to total life expectancy (88.0%). Between 2001–2002 and 2011–2012, years lived without physical/cognitive impairment decreased for men (0.13 years,  $-0.27$ – $0.01$ ) but increased for women (0.59 years,  $0.40$ – $0.77$ ), both of which were less than the increases in total life expectancy (1.07 years for men and 1.10 years for women). In addition, the number of years lived with cognitive impairment tend to be higher than those for physical impairment for both men and women, although women experienced an improvement in cognitive function over time. Compared with men in EHC 2001–2002, men in EHC 2011–2012 lived more years with physical impairment (0.23 years,  $0.16$ – $0.31$ ), cognitive impairment (0.91 years,  $0.80$ – $1.02$ ), and both types of impairment (0.06 years,  $0.01$ – $0.11$ ). Compared with women in EHC 2001–2002, women in EHC 2011–2012 lived more years with physical impairment (0.66 years,  $0.58$ – $0.74$ ) and both types of impairment

(0.22 years,  $0.15$ – $0.29$ ), but less years with cognitive impairment ( $-0.36$  years,  $-0.52$ – $0.21$ ) (Table 4).

Assuming that the proportions of each type of impairment remain unchanged until 2041, the number of people aged 65 years or older living in the community with physical impairment is expected to increase from 13,000 for men and 29,000 for women in 2021 to 26,000 for men and 65,000 for women by 2041, or an increase of 101.3% for men and 126.5% for women, as populations age. The corresponding figures for cognitive impairment were 82.1% for men and 121.4% for women, and for both types of impairment, 128.6% for men and 135.5% for women, respectively. The number of carers needed is also expected to increase from 344,000 in 2021 to 629,000 by 2041, or an increase of 82.9% (Table 5). Sensitivity analyses were performed after an exclusion of the participants who had been assessed in 2011–2012 from EHC 2001–2002, where the results for the adjusted proportions of each type of impairment, the health expectancies, and the projected number of carers needed remained similar (Supplementary tables 1–5).

## Discussion

Life expectancy without physical/cognitive impairment at age 65 decreased for men but increased for women between 2001–2002 and 2011–2012, both of which were less than the increases in total life expectancy over the same period, consistent with the expansion of morbidity hypothesis. In addition, the number of years lived with cognitive impairment tend to be higher than those for physical impairment for both men and women, although women experienced an improvement in cognitive function over time. As populations age, the number of men living with physical and/or cognitive impairment will increase by roughly 82.1–128.6%, whereas for women, it will increase by 121.4–135.5% between 2021 and 2041. On the basis of these estimations, the number of carers needed in Hong Kong would reach 0.34 million by 2021, 0.51 million by 2031, and 0.63 million by 2041. These findings seem to substantiate the notion that increased longevity would be accompanied by a decline in functional capacity and an increase in care needs.

Between 2001–2002 and 2011–2012, we found significant increases in life expectancy with physical impairment. This expansion of physical impairment in Hong Kong was also observed in Japan and the UK. For example, findings from a previous Japanese study showed that the number of expected years with ADL limitation at age 65 increased between 1995 and 2004 (Hashimoto et al. 2010) and that the number of expected years with care needs at age 65 increased between 2005 and 2009 (Seko

**Table 2** Proportions of participants with and without physical and/or cognitive impairment in Elderly Health Centres in Hong Kong, 2001–2002 and 2011–2012

	EHC 2001–2002				EHC 2011–2012				<i>P</i> value
	Without physical/ cognitive impairment (%)	With physical impairment (%)	With cognitive impairment (%)	With both types of impairment (%)	Without physical/ cognitive impairment (%)	With physical impairment (%)	With cognitive impairment (%)	With both types of impairment (%)	
<i>Men</i>									
65–69	98.68	0.41	0.86	0.05	93.79	1.01	4.94	0.26	< 0.0001
70–74	98.22	0.52	1.17	0.1	93.35	1.12	5.15	0.38	< 0.0001
75–79	96.32	1.51	1.51	0.67	88.98	1.89	8.03	1.1	< 0.0001
80–84	95.25	1.62	2.65	0.48	87.07	3.95	8.01	0.97	< 0.0001
85+	90.07	2.26	4.7	2.96	79.79	5.18	12.44	2.59	< 0.0001
Total	97.01	0.87	1.69	0.43	91.02	1.98	6.32	0.68	< 0.0001
<i>Women</i>									
65–69	95.42	0.3	4.17	0.11	91.78	1.65	6.31	0.26	< 0.0001
70–74	92.79	0.37	6.58	0.25	93.22	1.86	4.7	0.21	< 0.0001
75–79	88.92	0.9	9.64	0.54	86.47	4.43	7.26	1.85	< 0.0001
80–84	83.68	1	14.19	1.14	81.37	5.69	10.45	2.49	< 0.0001
85+	70.33	3.08	23.31	3.29	70.32	8.98	13.84	6.86	< 0.0001
Total	88.41	0.88	9.95	0.77	86.44	3.9	7.9	1.77	< 0.0001

Both EHC 2001–2002 and EHC 2011–2012 were standardized by indirect method using the Hong Kong population in 2011 as reference  
 EHC Elderly Health Centre

**Table 3** Adjusted proportions of participants with and without physical and/or cognitive impairment in Elderly Health Centres in Hong Kong, 2001–2002 and 2011–2012

	EHC 2001–2002				EHC 2011–2012				P value
	Without physical/ cognitive impairment (%)		With both types of impairment (%)		Without physical/ cognitive impairment (%)		With both types of impairment (%)		
	With physical impairment (%)	With cognitive impairment (%)	With physical impairment (%)	With cognitive impairment (%)	With physical impairment (%)	With cognitive impairment (%)	With physical impairment (%)	With cognitive impairment (%)	
<i>Men</i>									
Model 1 Adjusted for age and period									
65–69	98.54	0.36	1.03	0.07	95.08	0.84	3.97	0.11	< 0.0001
70–74	97.94	0.56	1.35	0.15	93.19	1.33	5.23	0.25	< 0.0001
75–79	96.91	0.91	1.83	0.35	90.62	2.05	6.79	0.54	< 0.0001
80–84	95.28	1.46	2.45	0.80	86.64	3.23	8.89	1.23	< 0.0001
85+	91.80	2.55	3.40	2.25	79.79	5.30	11.69	3.22	< 0.0001
Total	97.01	0.87	1.69	0.43	91.02	1.98	6.32	0.68	< 0.0001
Mode 2 Adjusted for factors in Model 1 + marital status and levels of education									
65–69	98.53	0.36	1.04	0.07	95.10	0.83	3.96	0.10	< 0.0001
70–74	97.94	0.56	1.34	0.15	93.24	1.33	5.20	0.23	< 0.0001
75–79	96.94	0.91	1.80	0.35	90.61	2.06	6.79	0.53	< 0.0001
80–84	95.31	1.46	2.44	0.79	86.36	3.25	9.10	1.29	< 0.0001
85+	91.70	2.57	3.48	2.25	80.06	5.24	11.49	3.21	< 0.0001
Total	97.01	0.87	1.68	0.43	91.02	1.98	6.32	0.68	< 0.0001
Mode 3 Adjusted for factors in Model 2 + chronic disabling diseases and hearing and eyesight problems									
65–69	98.54	0.36	1.03	0.07	95.03	0.78	4.09	0.10	< 0.0001
70–74	97.93	0.57	1.34	0.15	93.32	1.30	5.16	0.22	< 0.0001
75–79	96.92	0.93	1.80	0.35	90.73	2.07	6.67	0.52	< 0.0001
80–84	95.28	1.48	2.43	0.81	86.32	3.40	8.96	1.32	< 0.0001
85+	91.84	2.42	3.54	2.20	79.79	5.25	11.72	3.24	< 0.0001
Total	97.01	0.87	1.68	0.43	91.02	1.98	6.32	0.68	< 0.0001
<i>Women</i>									
Model 1 Adjusted for age and period									
65–69	94.99	0.28	4.65	0.08	94.91	1.23	3.68	0.18	< 0.0001
70–74	92.63	0.47	6.72	0.18	92.05	2.10	5.42	0.43	< 0.0001
75–79	88.85	0.80	9.90	0.46	88.06	3.37	7.59	0.98	< 0.0001
80–84	83.43	1.32	14.15	1.10	81.08	5.64	10.87	2.41	< 0.0001
85+	73.34	2.37	20.97	3.32	68.69	9.48	15.20	6.62	< 0.0001
Total	88.41	0.88	9.95	0.77	86.44	3.90	7.90	1.77	< 0.0001

**Table 3** (continued)

	EHC 2001–2002				EHC 2011–2012				P value
	Without physical/ cognitive impairment (%)	With physical impairment (%)	With cognitive impairment (%)	With both types of impairment (%)	Without physical/ cognitive impairment (%)	With physical impairment (%)	With cognitive impairment (%)	With both types of impairment (%)	
Mode 2 Adjusted for factors in Model 1 + marital status and levels of education									
65–69	94.91	0.28	4.73	0.08	95.41	1.23	3.21	0.15	< 0.0001
70–74	92.22	0.47	7.12	0.19	92.61	2.09	4.90	0.40	< 0.0001
75–79	88.72	0.80	10.01	0.46	88.02	3.39	7.62	0.96	< 0.0001
80–84	83.73	1.32	13.85	1.10	79.92	5.65	11.94	2.50	< 0.0001
85+	74.11	2.36	20.23	3.30	68.42	9.48	15.50	6.60	< 0.0001
Total	88.41	0.88	9.94	0.77	86.44	3.90	7.90	1.76	< 0.0001
Mode 3 Adjusted for factors in Model 2 + chronic disabling diseases and hearing and eyesight problems									
65–69	94.83	0.29	4.80	0.08	95.40	1.15	3.29	0.15	< 0.0001
70–74	92.17	0.49	7.15	0.19	92.76	2.04	4.81	0.39	< 0.0001
75–79	88.74	0.83	9.97	0.47	88.10	3.43	7.52	0.95	< 0.0001
80–84	83.82	1.34	13.73	1.11	79.78	5.82	11.88	2.52	< 0.0001
85+	74.23	2.25	20.26	3.27	68.24	9.44	15.71	6.61	< 0.0001
Total	88.41	0.88	9.94	0.77	86.44	3.90	7.90	1.76	< 0.0001

Both EHC 2001–2002 and EHC 2011–2012 were standardized by indirect method using the Hong Kong population of 2011 as reference

Both EHC 2001–2002 and EHC 2011–2012 were standardized by indirect method using the Hong Kong population of 2011 as reference

Model 1, adjusted for age and period

Model 2, adjusted for factors in Model 1 + marital status and levels of education

Model 3, adjusted for factors in Model 2 + chronic disabling diseases and hearing and eyesight problems

*EHC* Elderly Health Centre



**Table 4** Life and health expectancies and proportions of life expectancies with and without physical and/or cognitive impairment at age 65 of participants of Elderly Health Centres in Hong Kong, 2001–2002 and 2011–2012

	EHC 2001–2002 Years (95% CI)	EHC 2011–2012 Years (95% CI)	Difference
<i>Men</i>			
Total life expectancy	17.23	18.30	1.07
Life expectancy without physical/ cognitive impairment	16.67 (16.61, 16.73)	16.54 (16.46, 16.61)	– 0.13 (– 0.27, 0.01)
Life expectancy with physical impairment	0.16 (0.13, 0.20)	0.40 (0.36, 0.44)	0.23 (0.16, 0.31)
Life expectancy with cognitive impairment	0.31 (0.26, 0.35)	1.22 (1.15, 1.28)	0.91 (0.80, 1.02)
Life expectancy with both types of impairment	0.09 (0.06, 0.12)	0.15 (0.13, 0.17)	0.06 (0.01, 0.11)
Proportion of life expectancy spent			
Without physical/cognitive impairment	96.76% (96.41%, 97.11%)	90.35% (89.93%, 90.77%)	– 6.41% (– 7.70%, – 5.12%)
With physical impairment	0.95% (0.75%, 1.14%)	2.17% (1.97%, 2.38%)	1.23% (0.58%, 1.87%)
With cognitive impairment	1.78% (1.53%, 2.03%)	6.66% (6.30%, 7.02%)	4.88% (3.81%, 5.95%)
With both types of impairment	0.52% (0.35%, 0.68%)	0.82% (0.69%, 0.95%)	0.30% (– 0.11%, 0.71%)
<i>Women</i>			
Total life expectancy	20.15	21.25	1.10
Life expectancy without physical/ cognitive impairment	17.72 (17.62, 17.83)	18.31 (18.23, 18.39)	0.59 (0.40, 0.77)
Life expectancy with physical impairment	0.19 (0.15, 0.22)	0.85 (0.80, 0.89)	0.66 (0.58, 0.74)
Life expectancy with cognitive impairment	2.07 (1.98, 2.17)	1.71 (1.65, 1.77)	– 0.36 (– 0.52, – 0.21)
Life expectancy with both types of impairment	0.17 (0.13, 0.21)	0.39 (0.36, 0.42)	0.22 (0.15, 0.29)
Proportion of life expectancy spent			
Without physical/cognitive impairment	87.95% (87.43%, 88.47%)	86.14% (85.78%, 86.50%)	– 1.80% (– 3.34%, – 0.27%)
With physical impairment	0.92% (0.75%, 1.09%)	3.99% (3.77%, 4.20%)	3.07% (2.25%, 3.89%)
With cognitive impairment	10.28% (9.80%, 10.77%)	8.04% (7.75%, 8.33%)	– 2.25% (– 3.49%, – 1.01%)
With both types of impairment	0.85% (0.66%, 1.03%)	1.83% (1.68%, 1.99%)	0.99% (0.41%, 1.56%)

Data are years (95% confidence Interval), unless specified

EHC Elderly Health Centre

et al. 2012). Findings from the English Longitudinal Study of Ageing also predicted that life expectancy with physical impairment/disability based on the capacity to perform ADL would increase over time (Guzman-Castillo, Ahmadi-Abhari et al. 2017). However, other countries (e.g. Australia) appeared to be experiencing compression of disability (Australian Institute of Health and Welfare 2014). Some reports in China also showed declining trends in disability (Feng et al. 2013; Liang et al. 2015), which could be due to improvements in living standards due to economic growth. The underlying causes of the increase in the gains in years lived with physical impairment observed in the present study, and those in the literature could be due to better survival among people with chronic disabling diseases (e.g. cancer, stroke), resulting in an eventual uptick in the disability burden. Recently, the *Lancet* reviewed 37.5 million cancer cases between 2000 and 2014 and revealed that five-year survival rates for most cancers have

improved (Allemani et al. 2018). Locally, a decline of case fatality for stroke was also observed between 1999 and 2007 (Woo et al. 2014).

Health expectancies, however, are most often calculated based on the capacity to perform ADL, often without any regard to cognitive functioning, although there have been studies reporting life expectancy with cognitive impairment (Suthers et al. 2003; Ashby-Mitchell et al. 2015; Jagger et al. 2016). Recently, the CFAS reported trends in years spent in different dependency states according to not only activity limitations but also geriatric conditions including incontinence and dementia. The CFAS compared two British cohorts of old people, aged 65 years or older, interviewed in 1991 and 2011 and reported that while life expectancy rises, the number of years older people have spent with greater levels of dependency and substantial care needs also increases (Kingston et al. 2017). In the present study, we found an increasing trend in cognitive



**Table 5** Projected number of people aged 65 years or older with and without physical and/or cognitive impairment and the corresponding projected number of carers needed in Hong Kong, 2021–2041

	Year			Total increase from 2021 to 2031 (% increase)	Total increase from 2021 to 2041 (% increase)
	2021	2031	2041		
<i>Projected number of older people (thousands)</i>					
Men					
Without physical/ cognitive impairment	615	884	954	269 (43.7%)	339 (55.2%)
With physical impairment	13	19	26	6 (49.7%)	13 (101.3%)
With cognitive impairment	42	61	76	20 (47.8%)	34 (82.1%)
With both types of impairment	5	7	10	2 (45.8%)	6 (128.6%)
Total	674	971	1066	297 (44.1%)	392 (40.4%)
Women					
Without physical/ cognitive impairment	677	1040	1267	363 (53.6%)	590 (87.2%)
With physical impairment	29	43	65	14 (48.4%)	36 (126.5%)
With cognitive impairment	58	88	128	30 (51.4%)	70 (121.4%)
With both types of impairment	14	19	32	5 (37.6%)	18 (135.5%)
Total	777	1189	1492	412 (53.0%)	715 (60.1%)
Both sexes	1451	2160	2558	709 (48.9%)	1107 (51.3%)
<i>Projected number of carers (thousands)<sup>a</sup></i>					
Men					
Without physical/ cognitive impairment	115	165	178	50 (43.7%)	63 (55.1%)
With physical impairment	6	9	12	3 (46.2%)	6 (100.0%)
With cognitive impairment	29	42	52	13 (45.2%)	23 (81.0%)
With both types of impairment	4	6	8	2 (40.0%)	4 (100.0%)
Total	153	221	250	67 (44.0%)	96 (62.9%)
Women					
Without physical/ cognitive impairment	126	194	236	68 (53.6%)	110 (87.1%)
With physical impairment	13	20	30	6 (48.3%)	16 (124.1%)
With cognitive impairment	40	60	88	21 (51.7%)	48 (120.7%)
With both types of impairment	11	15	25	4 (35.7%)	14 (128.6%)
Total	190	289	379	99 (51.8%)	189 (99.1%)
Both sexes	344	510	629	166 (48.3%)	285 (82.9%)

<sup>a</sup>According to a previous local study estimating the staffing needs for caring institutional population, the estimated care time for those with physical impairment was around 3.2 h/d, for those with cognitive impairment around 4.8 h/d, and for those with both physical and cognitive impairment around 5.5 h/d. Based on these estimates, and assuming that the age- and sex-specific rates for physical and/or cognitive impairment remain constant, the projected number of carers needed/24 h was estimated based on the following: estimated nursing and person care worker hours/24 h  $\times$  projected number of people aged 65 years or older/7 h, with the regular working hours per day being 7 (8 h shifts with 1 h lunch break included)

impairment in men but not in women. The underlying reasons are unknown, but the higher incidence of stroke among men can partly account for the increase (Woo et al. 2014) as stroke is considered an important cause of cognitive impairment. Another reason for the increase in cognitive impairment in men but not in women may be due to unhealthy lifestyle in mid-life (Sabia et al. 2009; Samieri

et al. 2013) which could affect cognitive function. In Hong Kong, many epidemiological studies show that men have more unhealthy lifestyles with respect to diet and smoking (Chan et al. 2008; Chan and Leung 2015). Increased awareness of cognitive impairment through effective public education and awareness activities about dementia in Hong Kong could have increased the percentages.

However, the rates of cognitive impairment among women did not follow the pattern among men. Instead, we found a decreasing trend in women over time. Improvement in education levels among women could have reduced the level of cognitive impairment in EHC 2011–2012. In addition, women were significantly more likely than men to participate in community-based activities in Hong Kong, where growing evidence has shown that greater social group participation could prevent cognitive decline in women (Tomioka et al. 2018). However, these are only speculations. Further independent investigations are required to examine the causes of these trends, as the answer to this has implications for health, social, and financial policies.

The decline in the proportion of years lived without physical/cognitive impairment to total life expectancy has a number of implications. One of the most important is that there may be an increased demand for elderly services. In the present study, we have also explored the needs of older people for care services and found that Hong Kong will need a substantial number of carers in the next 20 years. The increase in demand for carers has significant implications for the health and other sectors such as social, education, and labour; however a thorough investigation will be needed.

To meet the needs of the ageing population, health and care workforce capacity needs to be enhanced and demand for health and care services needs to be reduced. Both postponing retirement and workplace training may enhance workforce capacity. Interventions designed to optimize physical and cognitive functioning may reduce the demands for carers in the long term and should therefore be included in elderly service delivery model. Furthermore, a better care coordination between primary and specialist health care services as well as between health and social care services in the community, with emphasis on the involvement of informal care (either use of technology or family resources) may reduce people's reliance on high-cost health and care services, because community services and family resources can provide a substantial support for older people, which could contribute to better health outcomes and enable older people to live in the community independently.

## Strengths and limitations

Our measures of health capture not only the dimension of physical functioning but also cognitive functioning, which is an important dimension of health in older people. However, there are a number of limitations in our study. The community sample could lead to underestimation of the level of life expectancy with physical and/or cognitive impairment, as individuals living in the community are

more likely to have better health than those living in institutions. Moreover, the elders attending EHCs are a self-selected group who may be more health conscious and may not be representative of the general elderly population in Hong Kong. The removal of the participants who had been assessed in 2001–2002 from the EHC 2011–2012 may also introduce selection bias. Furthermore, we used constant age-sex-specific proportions of participants with physical and/or cognitive impairment for the projections which reflect the impact of demographic change alone. As the proportion of people with physical and/or cognitive impairment appears to have increased, the estimated number of people with physical and/or cognitive impairment would likely be larger than the projected figures. Furthermore, assessments for cognitive impairment were different between the two study periods, which may introduce some biases to the results, as the AMT has a lower sensitivity and specificity to detect cognitive impairment than the MMSE (MacKenzie et al. 1996). Nevertheless, a previous study has shown that the AMT was strongly associated with the MMSE in elderly patients (Swain et al. 1999). Similar finding has also been observed in a previous local study (Leung et al. 2017). In addition, the arbitrary cut-off scores from CMMSE would be expected to be less psychometrically robust compared with scores derived from a neuropsychological battery and may potentially lead to more false positives among older people with lower educational levels. Finally, the expected number of carer needs could be sensitive to assumptions about the future prevalence rates of physical and/or cognitive impairment, the severity of the impairment, as well as the unit man hours of services. Therefore, further analyses for the levels of severity of physical and/or cognitive impairment among older people in Hong Kong would complement this work and add much to understanding the health status and the needs of the older population.

## Conclusion

Increased life expectancy was not accompanied by an increase in years lived without physical/cognitive impairment. These findings suggest that people will live longer but could be more dependent, which would pose a substantial challenge to our society and emphasize the need for a multi-pronged strategy to enhance the health and care workforce capacity, to include prevention interventions in elderly service delivery model, and to increase the transfer of care into the community to meet future elderly service needs in Hong Kong.

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## Compliance with ethical standards

**Conflict of interest** All authors declare that he/she has no conflict of interest.

**Ethical approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

**Informed consent** Informed consent was obtained from all individual participants included in the study.

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