A life-course perspective on physical functioning in women

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Objective To validate Kalache & Kickbusch's model: namely, that functional capacity peaks in early adulthood, then declines at a rate dependent on fitness level until a "disability threshold" is reached.

Methods Data came from the Australian Longitudinal Study on Women's Health, which followed three cohorts from 1996 to 2011: a young, a mid-aged and an older cohort (born in 1973–78, 1946–51 and 1921–26, respectively). The Short Form (36) Health Survey was used to measure physical functioning (score 1–100). The disability threshold was the mean physical functioning score in older women requiring assistance with daily activities (62.8). The relationship between age and physical functioning was modelled using spline regression for the entire sample, and by baseline physical functioning quintile and physical activity level.

Findings Physical decline quickened with age: 0.05 annual units (95% confidence interval, CI: −0.13 to 0.22) at ages 18–23 years (i.e. no decline); −2.43 (95% CI: −2.64 to −2.23) at ages 82–90 years. Decline was faster in quintiles with lower baseline physical functioning in the younger and mid-age cohorts and in quintiles with higher baseline physical functioning in the older cohort. The disability threshold was reached at a mean age of 79 years, but the range was 45–88 years, depending on baseline physical functioning and physical activity.

Conclusion Age and physical decline are not linearly related, as traditionally believed; decline accelerates with age. However, baseline physical functioning, but not physical activity, influences the rate of decline.

Abstracts in عربي, 中文, Français, Русский and Español at the end of each article.

Introduction

In 1997, Kalache & Kickbusch, then of the World Health Organization's Ageing and Health programme, published a report[1] containing a figure (Fig. 1) that summarized a concept unchallenged until now: that functional capacities – i.e. respiratory capacity, muscular strength and cardiovascular performance – increase and peak during early adulthood and then decline linearly with advancing age. The two diverging lines in the graphic, which show how widely physical capacity can theoretically vary over the lifespan across the population, suggest that in early adulthood everyone has similar functional capacity but that the subsequent rate of decline depends on lifestyle and environmental factors. As people age, this creates an increasing gap in capacity across the population – the so-called fitness gap. Consequently, people with lower peak functional capacity reach the "disability threshold" – i.e. need help with daily activities and care – at a younger age than those who start off with higher peak functional capacity. The shaded boxes indicate the interventions applicable at different stages in life as dictated by this model.

The model represented by the figure described above has traditionally inspired health promotion initiatives worldwide.[2,3] However, no study that we know of has tested the validity of the model, specifically: (i) the shape describing the relationship between age and functioning; (ii) the rate of decline as a function of peak capacity level and the consequential fitness gap; and (iii) the moment in life in which the disability threshold is reached. Generating better evidence surrounding all of these aspects is important for planning interventions.

The figure developed by Kalache & Kickbusch focused on "functional capacity", a term synonymous with "fitness".[1] These terms, together with "physical functioning", denote the individual's capacity to undertake everyday tasks.[4] A different but related concept is that of physical activity, defined as "any bodily movement produced by skeletal muscles that results in energy expenditure".[5] "Physical activity" refers, in other words, not to the capacity to do something, but to what one actually does. Previous studies of mid-age and older adults show that more active people have better levels of physical functioning.[6–13] The proposed mechanism behind this association is that physical activity helps to maintain muscle and cardiac function and subsequently prevents functional decline.[14,15] If this is true, patterns of functional capacity may differ for people with low and high levels of physical activity.

The aim of this study was to verify and quantify the theoretical model suggested by Kalache & Kickbusch by answering the following research questions:

i) What is the rate of decline in physical functioning at different stages of the adult life course?
ii) What is the average age at which women reach the disability threshold?

Since data on functional capacities were not available for this study, we focused on physical functioning as measured with the Short Form (36) Health Survey (SF-36). To quantify the fitness gap, we stratified the analyses by baseline level of physical functioning. To determine whether physical activity influences the rate of decline in physical functioning and hence the age when the disability threshold is reached, we also

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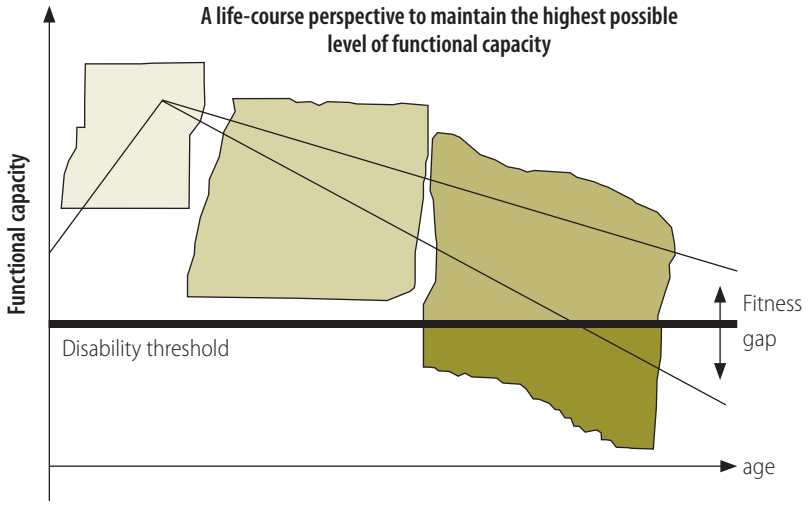
Fig. 1. **Theoretical framework illustrating changes in functional capacity across the life course and potential interventions for maintaining the highest possible level of functional capacity**



Maintaining an optimal physical, mental and social capacity from birth to death is a lifetime process requiring interventions by individuals, communities and health services throughout the whole span of life.
Source: Ageing and Health Programme, World Health Organization. Reproduced with permission from Kalache & Kickbusch, 1997.[1]

stratified the analyses for baseline level of physical activity.

Methods

Participants

Data were obtained from the Australian Longitudinal Study on Women's Health, a large population-based study of factors affecting health and well-being in three cohorts of women: a younger cohort (birth in 1973–78); a mid-age cohort (birth in 1946–51) and an older cohort (birth in 1921–26).[16] The study methods were approved by the human research ethics committees of the Universities of Newcastle and Queensland and all participants signed informed consent. Detailed information on design, recruitment and attrition can be found elsewhere.[16,17] Briefly, in 1996 women aged 18–23, 45–50 and 70–75 were randomly selected from the Medicare database, which includes all Australian citizens and permanent residents, and were mailed information packs, an invitation to participate in the study and survey materials, including the SF-36.[18,19] No selection or exclusion criteria were applied. Women from rural and remote areas were oversampled to capture the experiences of women outside the metropolitan area. After 1996 follow-up surveys were completed on a rolling basis at 2–3-year intervals until 2011: four in the younger cohort and five in the mid-age and older cohorts. The 1996 survey included 14 247 younger, 13 715 mid-age and 12 432 older women, respectively. Table 1 shows participant retention rates.

As we were interested in functioning over the life course and in the general population, we did not select participants based on disease status. If women had any diseases that limited their functioning, they were included in the study nonetheless.

Physical functioning and disability threshold

The SF-36 subscale[18,19] explores, through 10 items, whether any health-related conditions limit the respondent's ability to perform a range of daily tasks, some involving vigorous and moderate activity, or to climb stairs, move about and engage in self-care. The score ranges from 0 to 100 and higher scores indicate better physical functioning. In each cohort, we classified baseline physical functioning into quintiles to represent physical functioning as a continuum while also capturing the groups with the best and poorest levels of functioning.

To quantify the disability threshold, we calculated the mean physical functioning score obtained in the fourth survey (2005) in women in the oldest cohort who had reached the disability threshold – i.e. those who reported needing help from another person to carry out any of several activities. These included grooming, eating, bathing/showering, dressing, getting up from a chair, walking inside the house, using the toilet, shopping for groceries, doing light or heavy housework, managing money, preparing meals, taking medications, using the telephone and engaging in leisure activities or hobbies. Questions and response options for these items were based on Gill et al. (1998).[20]

Physical activity

The baseline level of physical activity was assessed from responses to questions about the frequency of vigorous exercise (e.g. sports, aerobics) and moderate exercise (e.g. walking, swimming) in a usual week.[21] Participants were classified as engaging in the following levels of physical activity: none (moderate activity 0–1 times per week); low (moderate activity 2–4 times or vigorous activity 1–2 times per week); moderate (moderate activity 5–8 times or vigorous activity 3–5 times per week); or high (moderate activity ≥ 8 times or vigorous activity ≥ 5 times per week, or equivalent combination).

Other variables

We explored demographic variables and a few lifestyle variables besides physical activity for descriptive purposes. Area of residence was classified as urban, rural or remote. Response options for the highest educational qualification completed were collapsed into high school or lower and post-high school. Adequacy of the respondent's income was assessed by asking: "How do you manage on the income you have available?" Response options were collapsed into "impossible/difficult" or "not too bad/easy". Those reporting occasional or regular smoking at the time of the survey were classified as current smokers. Risky level of alcohol consumption was defined as 15 glasses or more per week or 3 or more per day.[22] (Further details can be obtained from the corresponding author on request.)

Table 1. **Retention rates in the three cohorts of the Australian Longitudinal Study on Women's Health**

Survey	Year	No. eligible[a]	Completed survey (%)[b]	Did not respond (%)[b]	Could not be contacted (%)[b]	Withdrawn (%)[b]	Deceased (%)[c]
Younger cohort (born 1973–78)							
Survey 1	1996	–	41–42[d]	–	–	–	–
Survey 2	1999	14 116	68.6	9.4	21.1	0.9	0.2
Survey 3	2003	13 887	65.4	4.7	28.5	1.4	0.2
Survey 4	2006	13 557	67.5	10.1	21.2	1.3	0.3
Survey 5	2009	13 337	61.5	15.0	22.7	0.9	0.4
Mid-age cohort (born 1946–51)							
Survey 1	1996	–	43–56[d]	–	–	–	–
Survey 2	1998	13 605	90.7	1.9	6.3	1.2	0.4
Survey 3	2001	13 310	84.3	7.5	7.0	1.2	0.8
Survey 4	2004	12 979	84.0	6.8	8.1	1.1	1.5
Survey 5	2007	12 694	83.8	7.8	6.6	1.8	2.2
Survey 6	2010	12 270	81.6	9.4	7.4	1.6	3.1
Older cohort (born 1921–26)							
Survey 1	1996	–	37–40[d]	–	–	–	–
Survey 2	1999	11 537	90.4	4.2	2.7	2.7	4.3
Survey 3	2002	10 185	84.9	8.4	2.9	3.8	8.8
Survey 4	2005	8530	83.9	6.9	6.0	3.2	15.0
Survey 5	2008	7001	79.4	9.1	9.2	2.3	22.0
Survey 6	2011	8491	65.5	7.5	6.0	21.0	23.1

[a] Participants were eligible if they returned the first survey in 1996 and had not withdrawn or died since.
[b] Percentage relative to the number of participants eligible for this survey.
[c] Percentage relative to the number of participants who returned the first survey.
[d] Exact response rates could not be calculated; presented proportions are estimates as published previously.[16]

Statistical analysis

We explored the baseline characteristics of each cohort separately. We compared women with complete data on physical functioning throughout all follow-up surveys with women with incomplete data using *t*-tests for age and χ^2 tests for categorical variables.

To quantify the rate of decline in physical functioning in each cohort, we used spline regression and assumed linear associations between knots. The first knot was placed at the upper end of the baseline age interval of each cohort (i.e. at ages 23, 50 and 75) to visualize potential regression-to-the-mean effects. We selected additional knots for each cohort separately by starting with a model that included knots at three-year intervals (e.g. younger cohort: ages 20, 23, 26, 29, 32 and 35) and subsequently removing knots that gave no statistically significant ($P \geq 0.05$) difference in regression coefficient (slope) with respect to the preceding age interval. We used robust standard errors to account for within-subject correlation. We conducted the main analyses only with cases having complete data but performed sensitivity analysis with all participants who had provided any data at any point. Using the knots as selected in the total sample, we plotted physical functioning against age for (i) each quintile of baseline physical functioning and (ii) each level of baseline physical activity. We used graphs to estimate the mean age when the disability threshold was reached in each subgroup.

Results

Of the 14 247, 13 715 and 12 432 younger, mid-age and older women who returned the first survey in 1996, 5635, 8092 and 2999 provided complete data on physical functioning over all five (younger women) or six (mid-age and older women) surveys. The women with complete data were on average 20.8 (standard deviation, SD: 1.5), 47.6 (SD: 1.5) and 72.3 (SD: 1.4) years old at baseline, respectively. Women with complete data were the same age as those with incomplete data but were better educated, less likely to report being smokers or having difficulty managing on their income and more likely to engage in moderate physical activity, and they had higher levels of baseline physical functioning ($P < 0.001$) (Table 2).

Overall, physical functioning declined with age and more rapid declines were observed at higher ages (Fig. 2). The decline ranged from none in women aged 18–23 years (slope: 0.05; 95% confidence interval, CI: −0.13 to 0.22) to more than 2 units annually in women aged 82–90 (slope −2.43; 95% CI: −2.64 to −2.23) (Table 3). The disability threshold – i.e. mean score for physical functioning in older women who reported that they needed help with daily activities – was 62.8. Across the three cohorts, the average age when the disability threshold was reached was 79 years. In the sensitivity analyses with participants with any data ($n_{younger} = 14\,243$; $n_{mid\text{-}age} = 13\,709$; $n_{older} = 12\,409$), a similar, slightly attenuated decline was observed (Table 3, Fig. 2) and the disability threshold was reached at an average age of 75 years.

In all three birth cohorts, the patterns of physical functioning over time clearly differed as a function of baseline physical functioning quintile (Fig. 3). In the first years of follow-up, women with high baseline physical functioning showed a sharp decline, whereas those with poor baseline functioning showed a sharp increase. Towards the

Table 2. **Baseline (1996) characteristics of the younger, mid-age and older women in the Australian Longitudinal Study on Women's Health**

Characteristic	Younger cohort		*P*	Mid-age cohort		*P*	Older cohort		*P*
	Complete data	Incomplete data		Complete data	Incomplete data		Complete data	Incomplete data	
No. of participants	5635	8612	–	8092	5623	–	2999	9433	–
Age range (years)	18–23	18–23	–	45–50	45–50	–	70–75	70–75	–
Age (years), mean (SD)	20.8 (1.5)	20.7 (1.5)	< 0.001	47.6 (1.5)	47.6 (1.5)	0.31	72.3 (1.4)	72.6 (1.5)	< 0.001
Living in rural/remote area (%)	44.7	44.8	0.90	64.8	61.9	< 0.001	58.6	59.7	0.28
Post high school diploma (%)	32.1	27.3	< 0.001	37.2	27.1	< 0.001	19.7	13.2	< 0.001
Difficulty managing on income (%)	46.8	54.8	< 0.001	39.8	49.4	< 0.001	22.3	27.9	< 0.001
Current smoker (%)	26.3	36.5	< 0.001	14.3	24.5	< 0.001	4.0	8.7	< 0.001
Risky level of alcohol intake (%)	5.0	5.9	0.02	5.0	5.6	0.15	3.6	3.4	0.51
Physical activity level (%)			0.001			< 0.001			< 0.001
None	13.8	16.0	–	25.3	30.9	–	18.9	33.0	–
Low	29.1	28.7	–	31.7	29.0	–	32.0	27.5	–
Moderate	27.1	24.9	–	27.2	22.9	–	34.7	28.0	–
High	29.9	30.5	–	15.8	17.2	–	14.4	11.6	–
Baseline physical functioning, mean (SD)	91.9 (0.2)	88.9 (0.2)	< 0.001	87.3 (0.2)	82.4 (0.3)	< 0.001	71.2 (0.4)	60.4 (0.3)	< 0.001

SD, standard deviation.

end of the follow-up, however, the rate of decline was greater in quintiles with lower baseline physical functioning in the younger and mid-age cohorts. (This was evidenced by greater negative slopes that fell outside the 95% CIs of the higher quintiles, Table 4). In contrast, in older women the rate of decline during the later years of follow-up was greater among those with higher baseline physical functioning (Table 4).

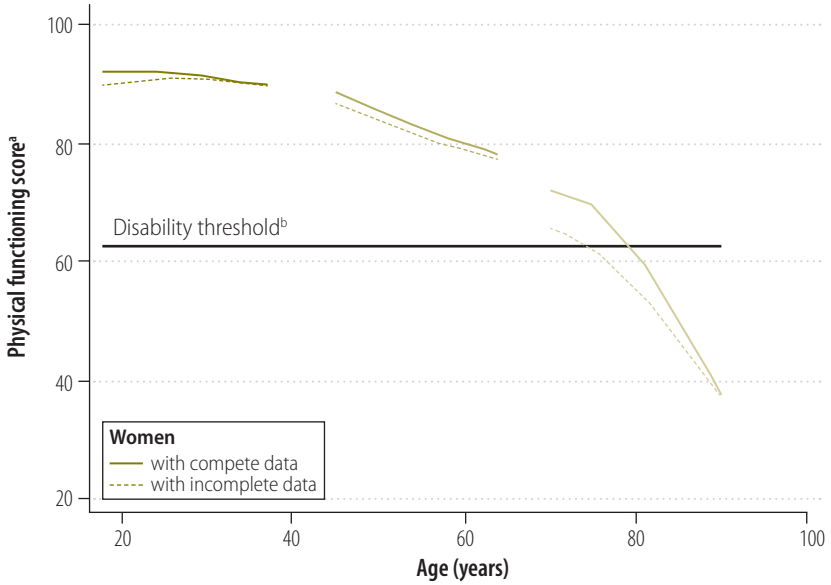
No younger or mid-age women who were in the four highest quintiles of baseline physical functioning reached the disability threshold during follow-up (Fig. 3). In younger women, the lowest quintile started at the disability threshold but improved rapidly (possibly due to regression-to-the-mean) and remained above this threshold during follow-up. In mid-age women, the lowest quintile started at the disability threshold and remained below it during follow-up. In the oldest women, the lowest two quintiles started at the threshold and remained below it throughout follow-up, whereas in the three highest quintiles, women started above the threshold but ended below it. In these three quintiles, women reached the disability threshold at an average age of 77.5, 83.5 and 88 years, respectively.

When the relationship was stratified by baseline level of physical activity, those with higher levels of activity started at higher levels of functioning, but rates of decline were similar in all activity groups (Fig. 4). In the younger and mid-age cohorts, the levels of physical functioning remained above the disability threshold, regardless of level of physical activity. In the oldest cohort, the disability threshold was reached at an average age of 70, 78, 80.5 and 84 years in the groups that reported no physical activity, low activity, moderate activity and high activity, respectively.

Discussion

The aim of this study was to verify and quantify the theoretical physical capacity model suggested by Kalache & Kickbusch.[1] Clear differences were observed between the theoretical model (Fig. 1) and the empirical data in various respects: (i) the shape of the relationship between age and functioning (Fig. 2); (ii) the rate of decline as a function of physical capacity levels at baseline (Fig. 3); (iii) the spread of physical functioning scores (Fig. 3); and (iv) the

Fig. 2. **Decline in physical functioning with age**



[a] SF-36 physical functioning subscale, range 0-100 with higher scores indicating better functioning.
[b] The mean level of functioning in women in the oldest cohort who reported needing assistance with daily activities in the fourth survey (2005).
Note: The association between physical functioning and age is presented for younger (dark green lines, ages 18–39), mid-age (mid-green lines, ages 45–64) and older (light green lines, ages 70–90) women. The horizontal black line at 62.8 on the *y*-axis indicates the disability threshold, defined as the mean level of functioning in women in the oldest cohort who reported needing assistance with daily activities in the fourth survey (2005).
Source: Data obtained from the Australian Longitudinal Study on Women's Health.

age when the disability threshold is reached. The most important findings of this study are that the rate of decline of physical functioning is not constant, as postulated in the original paper, but rather, that it increases with age. Furthermore, there is considerable spread in physical functioning (fitness gap) throughout the life course.

The first difference between the theoretical and empirical models lies in the shape of the modelled relationship between age and functioning. This is not linear, as in the original model, but curvilinear, with decline occurring more rapidly at older ages. To our knowledge, only one other study has published life-course data on physical functioning and that study showed a similar curvilinear pattern.[23] Furthermore, the theoretical model suggested that functioning improves in childhood and adolescence but undergoes a sharp decline when a person moves into adulthood.[1] Our results have shown that functioning levels are stable between the ages of 18 and 23 years (Table 2), but that a small but statistically significant decline ensues. The rate of decline was greater at younger ages in the mid-age cohort, although throughout the mid-age period the average decline seemed to slow down rather than to accelerate. One explanation for the higher rate of decline observed in women aged 45–50 years when compared with women aged 51–64 may be that in the former age group the menopause causes symptoms that lead women to perceive their physical functioning as declining more rapidly.[24,25] In women moving from middle into early old age, the rate of decline was in approximately the same range, but in old age it increased from 0.5 to 2.4 units annually (on a 0–100 scale).

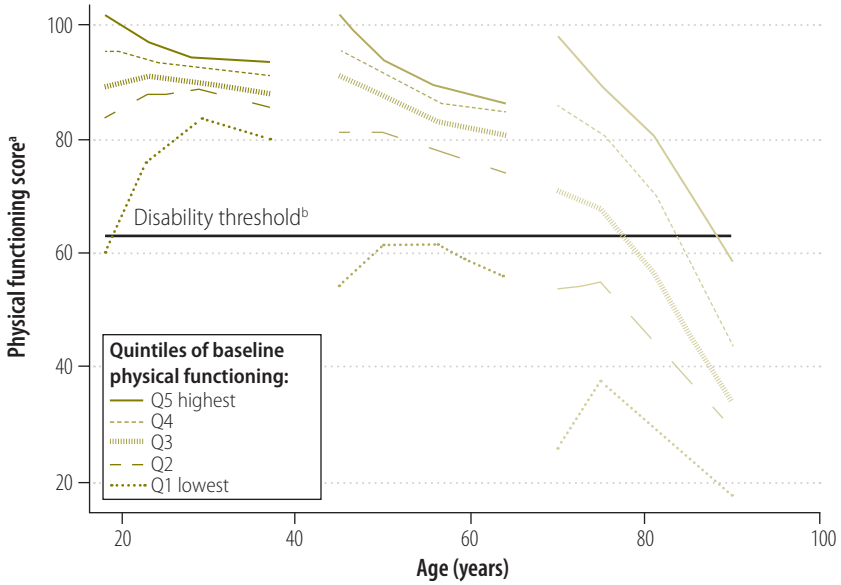
The second difference between the theoretical model and our findings is that, even at younger ages, physical functioning varies widely (Fig. 3). This finding is clinically important because it means that interventions to help those with poorer physical functioning at baseline need to be implemented at a much younger age. Furthermore, in all three cohorts, a sharp decrease in physical functioning was observed in women in the highest quintile of baseline physical functioning, whereas a sharp increase was observed in women in the lowest quintile. This suggests a regression to the mean between the first and second surveys.[26] After the first knot in the spline models (and the fading out of the regression-to-the-

Table 3. **Rate of decline in physical functioning in each of the three cohorts in the Australian Longitudinal Study on Women's Health**

Cohort	Age	Complete cases			Participants with any data		
		Intercept[a]	Slope[b]	95% CI	Intercept[a]	Slope[b]	95% CI
Young	18–23	92.4	0.05	−0.13 to 0.22	90.2	0.19	0.06 to 0.33
	24–29	–	−0.11	−0.20 to −0.01	–	0.01	−0.07 to 0.09
	30–37	–	−0.20	−0.31 to −0.09	–	−0.14	−0.23 to −0.05
Mid-age	45–50	88.1	−0.73	−0.89 to −0.58	86.5	−0.60	−0.74 to −0.46
	51–56	–	−0.57	−0.67 to −0.47	–	−0.54	−0.63 to −0.45
	57–64	–	−0.46	−0.56 to −0.36	–	−0.38	−0.48 to −0.29
Older	70–75	72.1	−0.55	−0.89 to −0.20	65.8	−0.67	−0.89 to −0.44
	76–81	–	−1.67	−1.89 to −1.45	–	−1.39	−1.54 to −1.24
	82–90	–	−2.43	−2.64 to −2.23	–	−1.85	−2.01 to −1.68

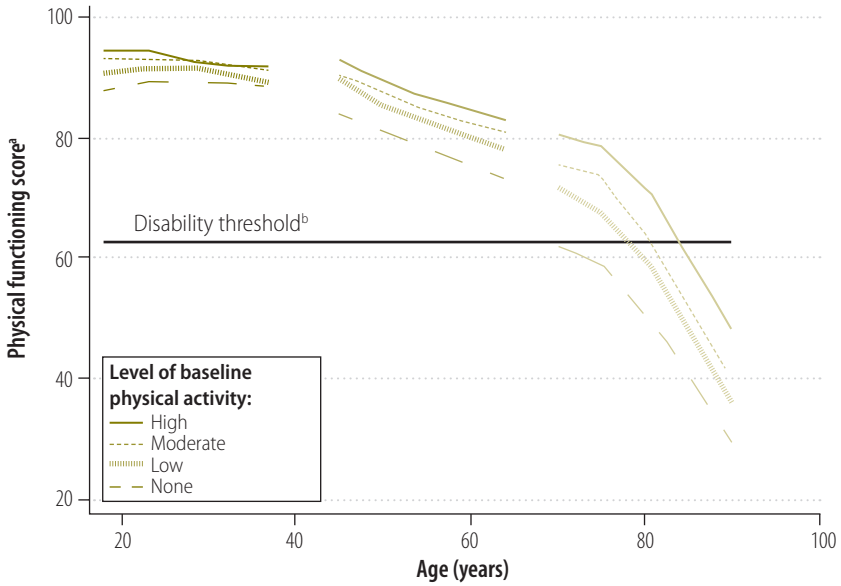
CI, confidence interval.
[a] Mean baseline physical functioning for women aged 18, 45 and 70 years in the younger, mid-age and older cohort, respectively.
[b] Rate of decline (indicated by slope) was estimated using spline regression, assuming linear relationships between knots (i.e. cut-off values in age): a negative slope indicates a decline; a positive slope indicates an improvement in physical functioning.

Fig. 3. **Decline in physical functioning with age, by baseline quintile of physical functioning**



[a] SF-36 physical functioning subscale, range 0-100 with higher scores indicating better functioning.
[b] The mean level of functioning in women in the oldest cohort who reported needing assistance with daily activities in the fourth survey (2005).
Note: The association between physical functioning and age is presented for younger (dark green lines), mid-age (mid-green lines) and older (light green lines) women. The horizontal black line at 62.8 on the *y*-axis indicates the disability threshold, defined as the mean level of functioning in women in the oldest cohort who reported needing assistance with daily activities in the fourth survey (2005).

Fig. 4. **Decline in physical functioning with age, by baseline level of physical activity**



[a] SF-36 physical functioning subscale, range 0-100 with higher scores indicating better functioning.
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mean effect), the rates of decline were greater in younger and mid-age women with lower baseline physical functioning than in those with higher baseline physical functioning. These patterns were in line with those of two studies in which cluster analyses were performed to identify trajectories of disabilities.[27,28] According to these studies, which were conducted in adults aged 15–74 and 55–85 years at baseline who were followed up for 5 and 6 years, respectively, trajectories characterized by more disabilities at baseline had more rapid rates of decline over time.[27,28] In the current study, however, the opposite was found among the oldest women, in whom a faster rate of decline was observed in those with higher baseline functioning. Again, this deviates from the pattern depicted by Kalache & Kickbusch but is in line with the findings of a study in which trajectory modelling was used to identify patterns of disability in men and women 70 years of age and older who were followed up for 10 years.[29] It may be that the levels of baseline physical functioning in the lowest quintiles were so low, particularly in the older women, that there was little room for further decline on the scale used.

The third noteworthy limitation of the theoretical model is its assumption that disability occurs only in older ages, whereas the empirical model shows that disability occurs at all ages. In our study, the average functioning levels of the lowest 20% of the sample of mid-aged women fell below the disability threshold and stayed below it during follow-up. Other studies have also quantified disability in middle adulthood. For example, in a representative sample of Swedish adults aged 18–75 years, mobility began to decline around the age of 40.[30] In a similar study in Belgium, moderate activity disabilities arose around the age of 25–34, while prevalence of severe activity disabilities increased at higher ages.[31] In a Danish cohort of men and women aged 40 and 50 at baseline, the prevalence of difficulty climbing stairs increased from 4% to 32% during 7 years of follow-up.[32] In the US Behavioural Risk Factor Surveillance System, 29% of 50–65 year old men and women reported having limitations in activity or requiring aids or adaptations.[33] Interventions for improving physical functioning and quality of life should therefore not be restricted

Table 4. **Rate of decline in physical functioning in each of the three cohorts in the Australian Longitudinal Study on Women's Health, by quintile of baseline physical functioning**

Cohort	Age	Baseline physical functioning quintile[a]									
		First		Second		Third		Fourth		Fifth	
		Slope	95% CI	Slope	95% CI	Slope	95% CI	Slope	95% CI	Slope	95% CI
Younger	18–23	3.15	2.42 to 3.88	0.75	0.40 to 1.09	0.41	0.21 to 0.61	−0.36	−0.52 to −0.20	−0.85	−0.98 to −0.72
	24–29	1.24	0.84 to 1.63	0.22	−0.10 to 0.55	−0.24	−0.45 to −0.04	−0.19	−0.33 to −0.04	−0.50	−0.61 to −0.39
	30–37	−0.44	−0.85 to −0.02	−0.40	−0.84 to 0.03	−0.22	−0.50 to 0.05	−0.19	−0.38 to −0.01	−0.06	−0.19 to 0.08
Mid-age	45–50	1.37	0.84 to 1.91	0.02	−0.18 to 0.23	−0.63	−0.84 to −0.41	−0.85	−1.01 to −0.69	−1.58	−1.71 to −1.44
	51–56	0.05	−0.27 to 0.38	−0.58	−0.76 to −0.41	−0.76	−0.95 to −0.58	−0.76	−0.90 to −0.62	−0.73	−0.86 to −0.61
	57–64	−0.74	−1.08 to −0.39	−0.48	−0.69 to −0.28	−0.30	−0.52 to −0.08	−0.26	−0.42 to −0.09	−0.39	−0.54 to −0.24
Older	70–75	2.35	1.61 to 3.08	0.32	−0.13 to 0.78	−0.61	−0.96 to −0.27	−0.97	−1.23 to −0.71	−1.70	−2.10 to −1.30
	76–81	−1.26	−1.81 to −0.72	−1.84	−2.24 to −1.44	−1.93	−2.26 to −1.60	−1.75	−2.02 to −1.48	−1.49	−1.91 to −1.06
	82–90	−1.41	−1.89 to −0.93	−1.64	−2.05 to −1.23	−2.46	−2.81 to −2.11	−2.97	−3.29 to −2.65	−2.44	−2.96 to −1.93

CI, confidence interval.

[a] The first quintile has the lowest level of physical functioning; the fifth has the highest.

Note: Rate of decline (indicated by slope) was estimated using spline regression, assuming linear relationships between knots (i.e. cut-off values in age): negative slope indicates decline, positive slope indicates increase in physical functioning.

to older women, but should include women of all ages with disabilities.

When we stratified physical functioning by baseline level of physical activity, we found that activity was associated with the baseline level of physical functioning but not with the course of physical functioning over time. A similar finding was reported in a study of 1297 people aged 55–85 years in the Netherlands. In this cohort, being physically inactive at older ages was not associated with a greater risk of physical decline. In contrast, both this Dutch study and a British study of mid-age adults showed that level of physical activity throughout adulthood was associated with physical functioning later in life.[6,34] As physical activity levels tend to fluctuate over time,[35] cumulative activity may be more important for functioning over time than activity at any given point. Also, high physical activity before the decline begins is important, since it is associated with higher baseline physical functioning and thus with later onset of disability.

Among the strengths of this study is the large population-based sample composed of three birth cohorts who provided 15 years of follow-up. A large proportion of the original sample (60%, 41% and 76% in the younger, mid-age and older cohorts, respectively) had missing data or had died or dropped out. Women with incomplete data were less educated, were more likely to be smokers and had lower levels of baseline physical functioning and physical activity than women with complete data, which suggests a healthy survivor bias. Repeating the analyses with all women who provided any data at any survey resulted in similar patterns, but with slightly attenuated rates of decline (Table 3; Fig. 2). Also, linear associations were assumed between knots in the spline regression, even though the change in physical functioning over time was nonlinear, particularly in later life. In preliminary analyses, more complex models were examined, including higher-order polynomials and exponential functions. Since these functions added little to the explained variance of the models, the use of a simplified piecewise linear model that was easier to interpret was justified.

Conclusion

The rate of functional decline increased with age. Depending on baseline level of physical functioning, the average age when the disability threshold was reached (i.e. when a woman needs assistance with daily activities) ranged from 45 to 88. Physical activity was associated with baseline level of physical functioning but not with the rate of decline. The current results improve on and quantify the theoretical model proposed by Kalache & Kickbusch and have implications for the timing of interventions to maintain optimal levels of physical functioning in the population. ■

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ملخص

منظور شامل لكامل مسار الحياة بشأن الوظائف الجسمية لدى النساء

الغرض اعتماد نموذج Kalache & Kickbusch: بلوغ القدرة الوظيفية ذروتها في المرحلة المبكرة من البلوغ، ثم انخفاضها بمعدل يعتمد على مستوى اللياقة حتى بلوغ "عتبة العجز".

الطريقة تم الحصول على البيانات من دراسة طولانية في أستراليا حول صحة النساء، والتي تلت ثلاث مجموعات من عام 1996 إلى عام 2011: مجموعة صغيرة وفي منتصف العمر وأكبر عمراً (ولدت في الفترة من 1973 إلى 1978 وفي الفترة من 1946 إلى 1951 وفي الفترة من 1921 إلى 1926، على التوالي). وتم استخدام استقصاء الصحة الموجز (36) لقياس الوظائف الجسمية (الدرجة من 1 إلى 100). وكانت عتبة العجز هي متوسط درجة الوظائف الجسمية لدى النساء الأكبر سناً اللاتي يحتجن إلى المساعدة في الأنشطة اليومية (62.8). وتم نمذجة العلاقة بين السن والوظائف الجسمية باستخدام الارتداد الانحداري للعينة بأكملها وبواسطة المجموعات الخمسية للوظائف الجسمية عند خط الأساس ومستوى النشاط البدني.

النتائج زادت سرعة الانخفاض في الوظائف الجسمية مع العمر: 0.05 وحدة سنوية (فاصل الثقة 95 ٪، من 0.13− إلى 0.22) عند السن من 18 إلى 23 سنة (أي لا يوجد انخفاض)؛ 2.43− (فاصل الثقة 95 ٪: من 2.64− إلى 2.23−) عند السن من 82 إلى 90 سنة. وكان الانخفاض أسرع في المجموعات الخمسية الأقل من حيث الوظائف الجسمية عند خط الأساس في مجموعات منتصف العمر والمجموعات الأصغر وفي المجموعات الخمسية الأعلى من حيث الوظائف الجسمية عند خط الأساس في المجموعة الأكبر سناً. وتم بلوغ عتبة العجز عند متوسط عمر 79 سنة، ولكن تراوح النطاق من 45 إلى 88 سنة، بناءً على الوظائف الجسمية عند خط الأساس والنشاط البدني.

الاستنتاج لم يرتبط العمر والانخفاض في الوظائف الجسمية على نحو خطي، وفق الاعتقاد التقليدي؛ بل يتسارع الانخفاض مع العمر. وعلى الرغم من ذلك، تؤثر الوظائف الجسمية عند خط الأساس، وليس النشاط البدني، على معدل الانخفاض.

摘要

从整个生命历程的角度看女性身体机能

目的 验证 Kalache 和 Kickbusch 的模型：即，机能性能力在成年早期达到高峰，然后按依赖于健身水平的速度下降，直至达到“残疾门槛”。

方法 数据来自 1996 至 2011 年澳大利亚妇女健康纵向研究的三组样本：年轻、中年和老年组（分别在 1973-78、1946-51 和 1921-26 年代出生）。使用简表 (36) 健康调查测量身体机能 (1-100 分)。残疾阈值是日常活动需要协助的老年女性的平均身体机能分数 (62.8)。整个样本使用样条回归方法并按照基线身体机能五等分和体力活动水平建立年龄和身体机能之间关系的模型。

结果 随着年龄的增长，机能下降加快：18-23 岁为 0.05 年度单位 (95% 置信区间，CI: -0.13 至 0.22)（即，无下降）；82-90 岁为 -2.43(95% CI:-2.64 至 -2.23)。在年轻和中年组中基线身体机能较低的五分组机能下降更快，在老年组中基线身体机能更高的五分组机能下降更快。在平均年龄 79 岁达到残疾阈值，但根据基线身体机能和身体活动，其范围为 45-88 岁。

结论 年龄和机能下降不是传统上认为的线性相关，机能随着年龄的增长会加速下降。然而，基线身体机能（而不是身体活动）影响下降的速度。

Résumé

Une perspective sur le fonctionnement physique chez les femmes au cours de la vie

Objectif Valider le modèle de Kalache & Kickbusch, selon lequel la capacité fonctionnelle connaît un pic chez les jeunes adultes, puis diminue à une vitesse dépendant du niveau de forme physique jusqu'à ce qu'un «seuil d'incapacité» soit atteint.

Méthodes Les données proviennent de l'étude australienne longitudinale sur la santé des femmes, qui a suivi trois cohortes de sujets de 1996 à 2011: un groupe jeune, un groupe d'âge moyen et un groupe plus âgé (sujets nés entre 1973 et 1978, entre 1946 et 1951 et entre

1921 et 1926, respectivement). Le court formulaire (36 questions) sur la santé a été utilisé pour mesurer le fonctionnement physique (note de 1 à 100). Le seuil d'incapacité a été la note moyenne de fonctionnement physique chez les femmes âgées nécessitant une assistance pour les activités quotidiennes (62,8). La relation entre l'âge et le fonctionnement physique a été modélisée à l'aide d'une régression par spline pour l'ensemble de l'échantillon, et par quintile de fonctionnement physique de base et de niveau d'activité physique.

Résultats Le déclin physique s'accélère avec l'âge: 0,05 unités annuelles (intervalle de confiance à 95%, IC: –0,13 à 0,22) entre 18 et 23 ans (pas de déclin); –2,43 (IC à 95%: –2,64 à –2,23) entre 82 et 90 ans. Le déclin a été plus rapide pour les quintiles à fonctionnement physique de base inférieur dans les cohortes jeune et d'âge moyen et pour les quintiles à fonctionnement physique de base plus élevé dans la cohorte plus âgée. Le seuil d'incapacité a été atteint à un âge moyen de 79 ans, mais la fourchette allait de 45 à 88 ans, selon le niveau de fonctionnement physique de base et l'activité physique.

Conclusion L'âge et le déclin physique ne sont pas liés de façon linéaire, comme on le croit traditionnellement. Le déclin s'accélère avec l'âge. Cependant, le fonctionnement physique de base influe sur la vitesse du déclin, contrairement à l'activité physique.

Резюме

Физическое состояние женщин в течение жизненного цикла

Цель Проверить достоверность модели Калаша и Кикбуша (Kalache & Kickbusch), а именно, гипотезу, согласно которой функциональная активность достигает пика в раннем взрослом возрасте, после чего идет на убыль в темпе, зависящем от уровня физической подготовки, вплоть до достижения «порога инвалидности».

Методы Использовались данные Австралийского продольного исследования женского здоровья в трех группах участниц: молодого, среднего и пожилого возраста (родившихся в 1973–78 гг., 1946–51 гг. и 1921–26 гг. соответственно). Физическое состояние оценивалось по стобалльной системе (1–100) путем сокращенного (36) медицинского обследования. Порог инвалидности определялся как среднее значение показателя физического состояния у пожилых женщин, нуждающихся в посторонней помощи при выполнении повседневных занятий (62,8). Соотношение между возрастом и физическим состоянием моделировалось при помощи сплайновой регрессии по всей выборке и посредством квинтиля базового физического состояния и уровня физической активности.

Результаты Ухудшение физического состояния с возрастом ускоряется: от 0,05 единиц в год (доверительный интервал (ДИ) 95%: от -0,13 до 0,22) в возрасте 18–23 лет (то есть, ухудшение отсутствует); до -2,43 единиц (ДИ 95%: от -2,64 до -2,23) в возрасте 82–90 лет. Ухудшение проходило быстрее в квинтилях с более низким базовым уровнем физического состояния в группах молодого и среднего возраста и в квинтилях с более высоким уровнем физического состояния в группе старшего возраста. Порг инвалидности достигался в среднем к 79 годам, однако разброс по этому показателю составил от 45 до 88 лет и зависел от базового физического состояния и физической активности

Вывод Зависимость ухудшения физического состояния от возраста не является линейной, как считалось ранее; с возрастом ухудшение ускоряется. Тем не менее, скорость ухудшения зависит от базового физического состояния, а не от физической активности.

Resumen

Una perspectiva sobre el funcionamiento físico en las mujeres a lo largo del ciclo vital

Objetivo Validar el modelo de Kalache y Kickbusch; a saber, que la capacidad funcional alcanza su punto máximo en la edad adulta temprana y disminuye luego a un ritmo que depende del nivel de condición física hasta alcanzar el "umbral de la discapacidad".

Métodos Se tomaron los datos del Estudio Longitudinal Australiano sobre la salud de la mujer, que realizó el seguimiento de tres cohortes desde 1996 a 2011: una cohorte joven, una de mediana edad y una de edad avanzada (nacidas en 1973-1978, 1946-1951 y 1921-1926, respectivamente). Se utilizó el Cuestionario de Salud SF-36 para medir la función física (puntuación 1-100). El umbral de la discapacidad fue la puntuación media de la función física en las mujeres mayores que necesitan ayuda con las actividades cotidianas (62,8). Se concibió la relación entre la edad y la función física mediante una regresión por spline para toda la muestra, así como por quintil de funcionamiento físico basal y el nivel de actividad física.

Resultados El deterioro físico se aceleró con la edad: 0,05 unidades anuales (intervalo de confianza del 95%, IC: – 0,13 a 0,22) a las edades de 18 a 23 años (es decir, sin deterioro); –2,43 (IC del 95%: –2,64 a –2,23) a las edades de 82 a 90 años. El deterioro fue más rápido en los quintiles de menor función física basal en las cohortes más jóvenes y de mediana edad y en los quintiles de mayor funcionamiento físico basal en la cohorte de mayor edad. Se alcanzó el umbral de la discapacidad a una edad media de 79 años, pero el rango fue de 45 a 88 años, en función del funcionamiento físico basal y la actividad física.

Conclusión A diferencia de la creencia tradicional, la edad y el deterioro físico no guardan relacionan lineal, aunque el deterioro se acelera con la edad. Sin embargo, el funcionamiento físico basal, aunque no la actividad física, influye en la tasa de deterioro.

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