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ORIGINAL ARTICLE

Cognition-adjusted Dependency Ratio among later-life adults and the Role of Education

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ABSTRACT

The old age dependency ratio (OADR) is a measure used for ageing populations. It involves counting people aged 60 or 65 years to be 'dependents' and obtaining their ratio in reference to the working age adults. This purely chronological criterion on dependency is insufficient toward the current state of later-life adults who are in better health than in previous decades. As Thailand's population is ageing, facilitating its preparation in terms of health of its future population is important. In this study, the OADR is adjusted by integrating health status. Education is also analysed as to how much effect it has on ill-health prevalence.

Using two nationally-representative surveys instruments in Thailand, education-specific prevalence of poor cognition, along with instrumental activities of daily living and depression, were analysed with reference to current and projected population estimates. It is observed that there is a positive education gradient across all health indicators such as in 2016, above 40 percent of those below primary level of education had ill health status compared with less than 20 percent of those with above primary level.

Integrating age-, sex-, and education-specific prevalence for each indicator with population projections to the year 2050, lower projected numbers of persons with ill-health status are observed. Although such is the case of the observation, it is observed that education gradient has the largest effect size on lower cognitive performance. These results estimates prospective health and care needs and the preventive effect of education.

Keywords: population health, educational status, population forecast, health status, social determinants of health, population groups

INTRODUCTION

Population ageing is the increase in the share of late life adults in a population. This ageing of populations has been observed regardless whether it is a developed or less developed country. Older people aged 60 years and over in 1950 comprised about 8% of the total global population and in 2015, it was at 12%[1]. An influence to this population structure change is that the average number of years a person expects to live has been increasing over the past decades [2]. As people age, their health status deteriorates. Disabilities and various diseases become much prevalent[3]. These health issues can lead to limitations in functioning in various dimensions of health which can be physical, cognitive, and psychological.

Within these themes in ageing studies, there is a notion that reaching a particular age is the criteria for being considered an older person. And as it is, there are notions that a person of a certain is someone who would live in dependency. There are criticisms to this view because it solely considers chronological age. It homogenises a population subgroup regardless of social characteristics with a probable further variation in terms of health states. This calls for the need to refine some measures within the study of ageing and this has been the goal of some studies particularly those of Sanderson's and Scherbov's [4,5] . The contention is someone who is aged 60 years in recent years will have a life expectancy of that of a 43-year-old in 1800s. This is related to the observation that certain characteristics can change the speed of ageing for different persons[6]. Through this perspective, the traditional measure in demography, the old-age dependency ratio (OADR), must be reassessed as it is reflective only of dependency from the perspective of labour stock; the employability of people based on age [7].

The fundamental concern is that there would be a caveat on determining who among the people aged 60 years and over are to be considered as dependents from perspectives that include functioning and health state. Since many more among those currently in within these ages have better health functions than previous cohorts, considering everyone as dependent would be imprecise. Sanderson and Scherbov[5] had proposed such inclusion of health into the traditional definition whereby it becomes the adult disability dependency ratio (ADDR) where the ratio represents the number of adults at least aged 20 years with disabilities to those without disabilities. There are other studies that had built from this proposition. Muszyńska and Rau[8] expanded the OADR by providing weights and be able to decompose the rate and distinguish between those who healthy and unhealthy among the older people. Another study integrates a more specific dependency ratio based on a health dimension which is the cognition-adjusted dependency ratio (CADR)[9].

This paper integrates these said measures to describe the state of the population with ages at least 60 years in Thailand. There is scarcity in these aspects in the literature of ageing in developing countries. Thailand is a country that is experiencing population ageing because of various societal developments including the unexpected below-replacement fertility level in the 1980s[10]. In 2015, persons aged 60 years and above had been at 10.7 million while it was around 1.1 million in 1950[1]. Because of this situation, a number of studies has been done pertaining to the factors associated with health outcomes and health status of older persons[11-13] but recent aggregate measures for the Thai population have yet be observed.

Another aspect that has shortcomings is the intersection of health and socioeconomic status of the older population and how it is reflected in the measures of old-age dependency. In Thailand, it has been observed that there is a positive education effect of select health indicators, particularly self-rated health[14]. This is supported by the study by Loichinger and Pothisiri[15] where they had estimated the effect of education with the prevalence of ill-health based on the current population and how much impact it may have in future populations. What is lacking still in the literature is integrating the concepts and methods utilised in order to introduce refinements into traditional aggregate measures in the study of ageing. The assimilation of health and socioeconomic contexts of a society can reflect the current situation of society in such that people are living longer and may have improved circumstances than in previous decades[5,16].

This study aims to apply adjustments to the traditional measure and conceptualisation of old-age dependency through the use of education attainment and cognitive performance. This is done by presenting prevalence of poor health in the aspect of cognitive health by education attainment. Upon producing such estimates, these will be applied to current and future population figures in order to gauge the magnitude of impact on the number of persons with lower cognitive performance and also producing CADR.

METHODS

2.1. Data

The data sources for this study include cross-sectional data from surveys of older persons in Thailand and population projections by age, sex and educational attainment.

2.1.1. Information on older persons in Thailand

Thailand has collected much information on older persons over the past decades. This present study utilises two surveys: the Survey of Older Persons in Thailand (SOPT) and the Population Change and Well-being in the Context of Aging Society (PCWAS). The SOPT is a cross-sectional survey implemented at regular intervals in Thailand and as such, the data points for 2011 and 2014 are used for the current study. These surveys used a three-staged stratified sampling design covering individuals aged at least 50 years in both urban and rural areas across major regions in the country[17,18]. This study also used the PCWAS which was conducted by the College of Population Studies, Chulalongkorn University in 2016 to investigate the population features of Thailand concerning low fertility and ageing. For the ageing component, sample units were selected through four-stage clustered probability method involving persons aged at least 60 years from the five regions of the country[19]. For these three surveys, information on demographic and socioeconomic background along with self-reported health indicators of the respondents were collected. Although some health-related items are not consistently present across

these surveys; specifically, depression and anxiety symptoms and cognitive performance, the SOPT and PCWAS used standardised definitions in terminologies. This use of multiple time points is to analyse if there are trends in the health indicators which can be subsequently used in estimating prevalence rates for application to population projections.

Selected characteristics are presented in Table 1. The proportion of females and the those in the age group of 60-64-year-olds are consistently higher than other categories in all surveys. Primary education consists of 4 to 7 years of primary level of education which is compulsory. This category has the highest proportion in all three surveys but it is declining such that 75 per cent of the older population were included in it compared with about 69 per cent in 2016. Having any level above primary education is also increasing in proportion for the samples in 2011, 2014 and 2016. Sampling weights have been applied for the analyses of the three surveys to account for the spatial distribution of the older persons in Thailand.

Table 1. Descriptive statistics of samples; 2011, 2014, and 2016.

	2011	2014	2016
Sex			
Male	42.6	44.3	41.4
Female	57.5	55.8	58.6
Age distribution			
60-64	32.0	32.2	34.8
65-69	22.2	23.5	25.7
70-74	18.8	17.0	19.6
75-79	13.5	13.7	11.4
80 and over	13.6	13.6	8.5
Education distribution			
Below primary education	12.0	15.3	14.4
Primary education	75.0	68.5	68.8
Above primary education	13.0	16.2	16.8

Sources: 2011 SOPT, 2014 SOPT and 2016 PCWAS

2.1.2. Population projections by education attainment

Projecting the population with poor health in the future while referencing education attainment differentials, the population projections should also bear the age, sex and education characteristics. The Wittgenstein global population projections include this feature such that past and projected population data are by highest education attainment for 201 countries[20,21]. The base year for the projections id 2010 and the results are presented in 5-year intervals and differentiated by sex. The classification of education levels is based on ISCED97 which are: no education, incomplete primary, primary, completed lower secondary,

completed upper secondary and post-secondary.

The population projection results are for seven scenarios with varying assumptions including population processes of fertility, mortality and migration; and also education attainment. The assumptions utilised in these projections are borne of rigorous analysis of historical and current developments of such population processes. Opinion of experts about the future development of the parameters, which was collected through online survey, was also part of the assumptions. The strength of these education-specific projections is that they have been continuously updated and validated. It has to be noted that these population projections are deterministic and therefore uncertainty cannot be quantified. Rational reasoning and the comparison of outcomes on future scenarios regarding fertility, mortality and migration have to be considered for defining such uncertainty. Further information on method and assumptions of these projections are provided in Lutz et al.[20], Lutz, Butz, and KC[22] and KC, Potančoková, Bauer, Goujon, and Striessnig[23].

Table 2. Education composition of persons aged at least 60 years (in percentage) total and by sex in Thailand; 2015 and 2050.

	2015			2050		
	Total	**Male**	**Female**	**Total**	**Male**	**Female**
Less than primary education	10.7	7.9	13.0	5.2	5.2	5.1
Primary education	71.5	68.9	73.6	30.2	28.2	31.8
Above primary education	17.8	23.2	13.4	64.6	66.6	63.1

Source: Wittgenstein Centre for Demography and Global Human Capital, 2018

The medium variant among the scenarios are used here whereby medium assumptions for fertility, mortality and migration are combined with prospective education expansion based on national and global trends. The education attainment of persons aged 60 years old and over in Thailand between 2015 and 2050 are presented in Table 2. More males have attained above primary education in 2015. This difference dissipates in 2050 when both sexes have very similar levels such that majority of the population in later ages have higher than primary level of education. In Figure 1, this differentiation in age and education composition of the population in Thailand as a whole. The number of population in advanced ages increases in 2050. The education attainment of those in the younger age groups decrease but a great majority have higher education relative to those in older ages.

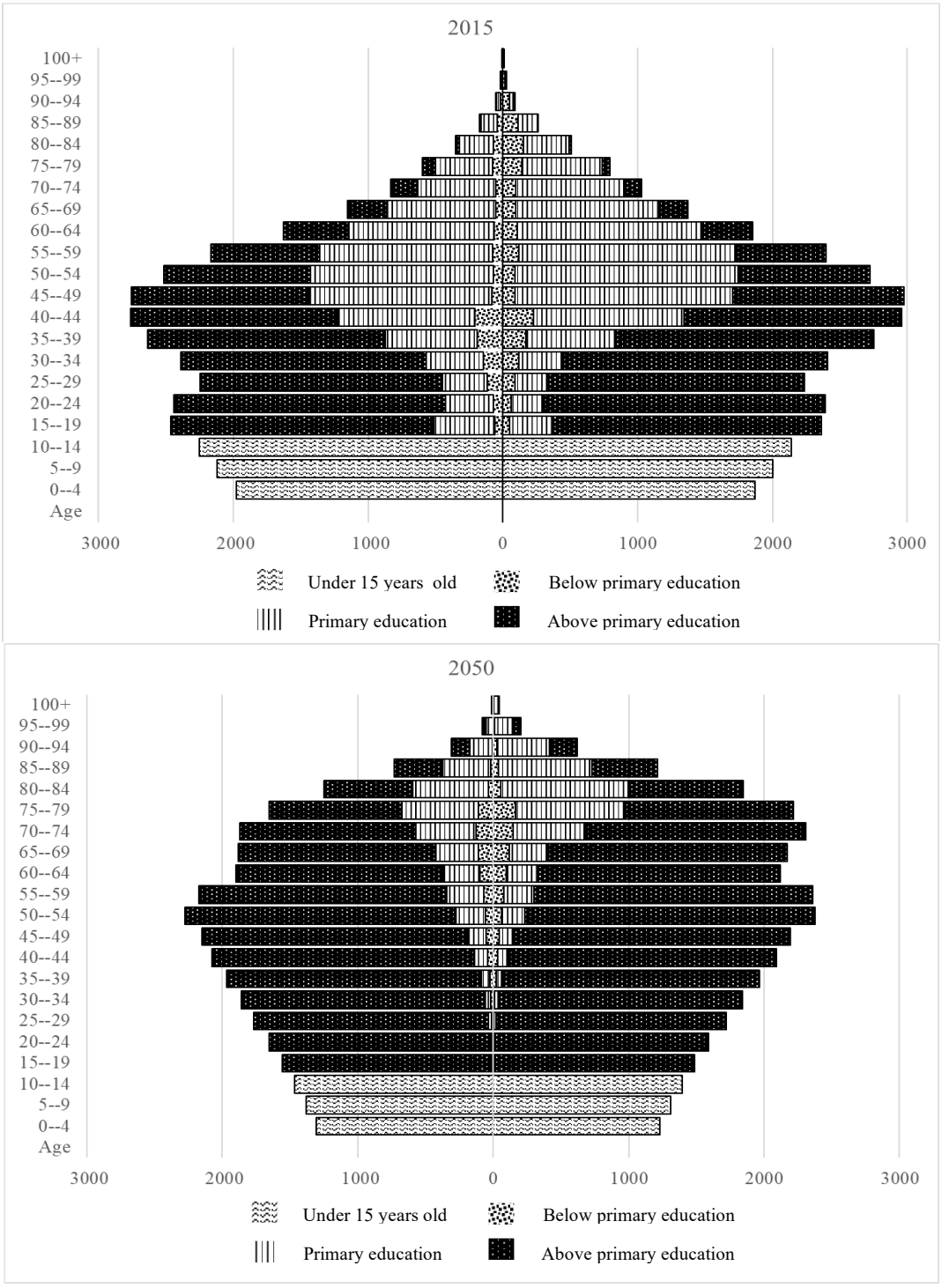

Figure 1: Population pyramids for Thailand, 2015 and 2050, by education attainment.
Source: Wittgenstein Centre for Demography and Global Human Capital, 2018

2.2. Methods of analyses

In congruence with the aim of this study to estimate the effect of education on the cognition-adjusted dependency ratio relating to current and future population, other health indicators are presented here for comparative purposes. Health measures that have been shown to be associated with cognition are instrumental activities of daily living (IADL)[24-26] and depressive symptoms[27-29]. The former is primarily an indicator of physical dimension of health but involves mental faculties to be completed compared with activities of daily living[30]. The latter on the other hand is a common co-morbidity such that a lower performance in either depression or cognitive impairment lowers the other as well[27] .

There are multiple procedures done for this study. The first sub-section presents the method used to distinguish the thresholds of who are to be considered healthy and those with poor-health status. These thresholds differ for each health dimension. Following this is the application of prevalence rates between the survey years in order to determine if there is a clear trend with regards to the development of the older-aged population with ill health. The next step is the application of prevalence rates to population projections. And ultimately, the method used for the estimation of current and future health-adjusted dependency ratios is presented.

2.2.1. Thresholds of poor health

A study by Skirbekk, Loichinger, and Weber[9] analysed the variation of cognitive functioning as an indicator of ageing. They had to distinguish those with good and poor cognitive performance. The ones with poor performance are those who had scored fewer than half the items in the cognitive test that they had used from the English Longitudinal Study of Aging (ELSA), Health and Retirement Study (HRS), World Health Organization Study on global AGEing and adult health (SAGE), and the Survey of Health, Aging, and Retirement in Europe (SHARE). With such an approach, they are able to compare indicators from different areas using various survey instruments. For the present study, the comparison is to be done across time using different surveys for Thailand. Another aspect to be noted is that the threshold of poor performance or poor health would have to depend on the health dimension, as it would be subsequently explored.

The central health dimension for this study is cognition. This is measured through the combination of recall and numeracy tests which represents what is called the principal cognitive function[31-33]. For this health dimension, the said tests are found in the PCWAS. The result that can be accrued for the cognitive recall test is at the maximum of six points. The test for numeracy capability on the other hand can have the maximum of two points. Ultimately, the total score then is eight points signifying having responded correctly to all the cognitive test questions. The threshold for being unhealthy in this health dimension is when the respondent is able to answer equal or fewer than half of the items[9].

In the following health dimensions of IADL and depression symptoms, both SOPTs and PCWAS were used specifically. IADL is based on three questions concerning the ability to take a bus, count money correctly, and taking medications completely

and correctly[34-36]. For this measure, having at least one limitation would be deemed as bearing an unhealthy status[15,36].

Depression is within the psychological dimension of health and in this paper, it is measured through select symptoms[37,38]. Depression symptoms included are the feeling of having no hope in life, feeling unhappy, and feeling lonely. Similar to the operationalisation of IADL, if an older person experiences at least one symptom, they are operationalised as unhealthy.

To obtain stable estimates for poor health, binary logistic regression was used as in previous studies[15,39]. The regression models were performed separately for males and females. Health measures were the dependent variables while the independent variables are age (categorised into five-year age groups starting with 60-64 years with the final category being 80 years and over) and education attainment (categorised into [1] Below primary education level, [2] Primary education and [3] Above primary education level). Other covariates were initially used including income levels, residence, living arrangement, health behaviour, and social engagement to gauge if any of them are statistically significant with the health outcomes. Statistically significant factors are selected then predicted probabilities are calculated. These probabilities are held constant and are incorporated in the final regression model analyses to show the true effects on the association of education with health status factors.

2.2.2. Prevalence of ill health

The generated predicted prevalence rates of poor health will be applied to the population distribution. Due to the education-specific development between the periods of analyses, direct standardisation is necessary as done by Loichinger and Pothisiri[15] based on the method presented by Naing[40]. The predicted prevalence rates for 2011, 2014 and 2016 are age-, sex- and education-specific. The standard population set for this study is the 2016 population structure by sex as computed from the 2016 PCWAS using sample weights.

2.2.3. Application of predicted rates to population projections

The age-, sex- and education- specific rates of poor health are applied to the population data which, as mentioned before, was based on the Wittgenstein global population projections. The rates are multiplied with the population data to assess the effect of change that education attainment differentials have on older population with ill health. In order to depict the total effect of education on the prevalence rates of ill health, a different set of predicted prevalence rates are estimated. In this latter analytical models, only age and sex were the factors. This created a reference point for comparing the predicted prevalence rates between an education-specific rates and the more general rates.

2.2.4. Health-adjusted dependency ratio

In the traditional measure, OADR is calculated as:

$$\frac{P_{60+}}{P_{15-59}} \qquad (1)$$

P_{60+} are those who are 60 years old and over and are considered as older persons; although in some cases, this is set at 65 years of age. $P_{15\text{-}59}$, of $P_{15\text{-}64}$, is composed of the working-age adults. There are novel approaches to determine dependency and this is done through integrating specific health

dimensions[5,8]. For this study, the method formulated by Skirbekk, Loichinger, and Weber[9] is used as it focuses on the older population while still considering those who are healthy and in ill health. In their paper, age variations in cognitive functioning is applied to old-age dependency ratio and defined the measure *cognition-adjusted dependency ratio*. This represented the ratio of older adults with poor cognitive performance to younger adults together with older adults who have good cognitive functioning. This is adapted to the current study due to the data available in Thailand which has the age threshold of 60 years and encompasses the three health dimensions.

$$\frac{P_{60+,ill-health}}{P_{15-59}+P_{60+,healthy}} \qquad (2)$$

The distinction between healthy and unhealthy is dependent on the nature of the health dimension. This is interpreted as the ratio of unhealthy older persons to all adults regardless of age.

RESULTS

The first section presents the predicted rates and how they manifest in the population by education differentials across the three periods of 2011, 2014 and 2016. Also included here is the prevalence rates by age group using the 2016 population as reference. The following section includes the application of predicted rates to the absolute number of populations from the projections and also the resulting health-adjusted dependency ratios.

3.1. Poor health and education differentials

Based on the prevalence rates adjusted by age structure changes over time, ill health can be generally characterised as having negative correlation with education attainment (Figure 2). The degree of such an observation differs between health indicators across the three time points. The advantage of those with increasing education attainment is evident in the prevalence of lower cognitive performance and IADL for both sexes. Depression symptoms among both sexes in 2011 is unique. There is little difference between having lower than primary education and having primary education. This changes in 2016 where the pattern becomes similar with the other health indicators.

In another aspect of comparison, prevalence rates of IADL and depression is observed to be higher among women. The prevalence of poorer cognitive performance of women with higher than primary education on the other hand, is lower than that of males.

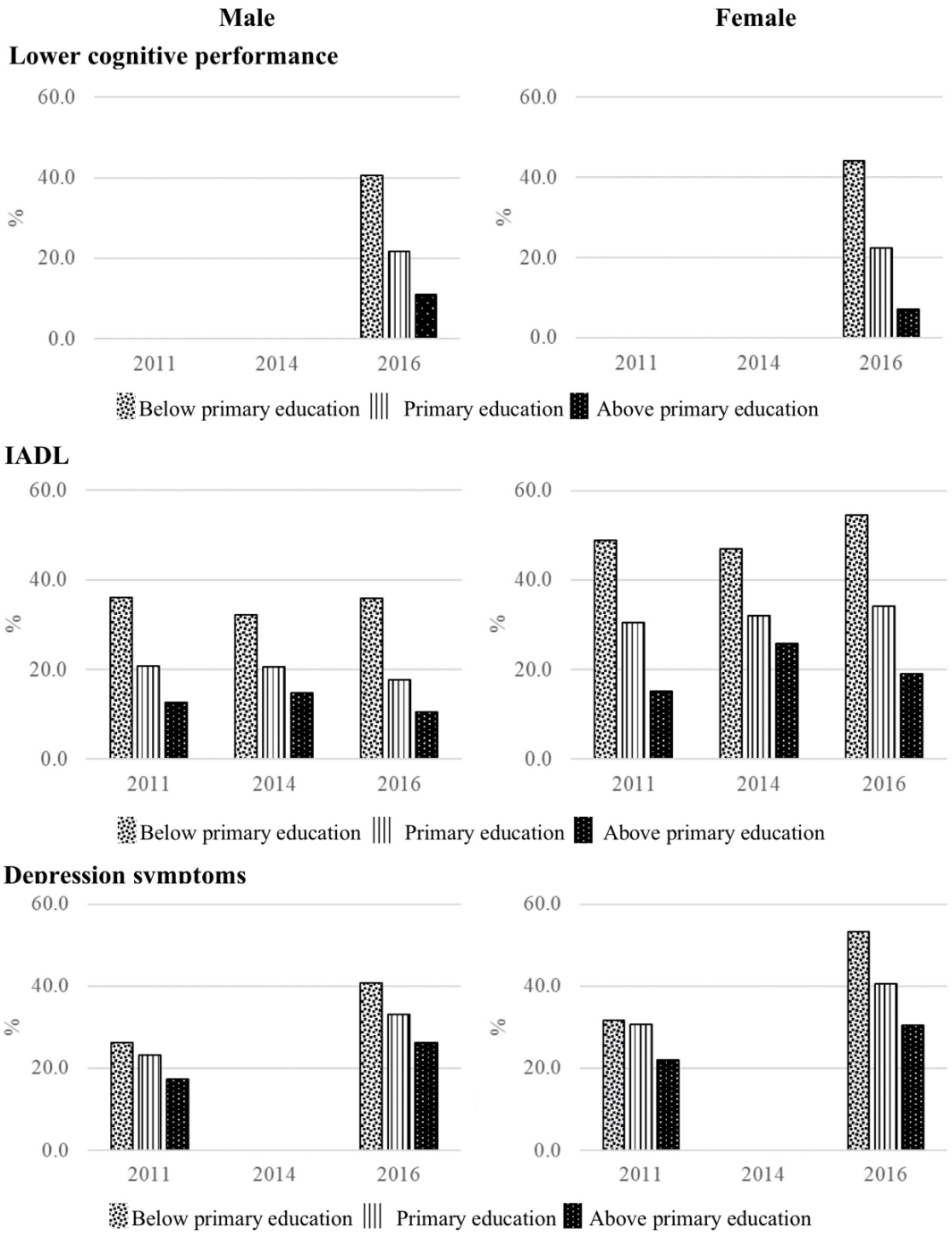

Figure 2: Prevalence of ill health status among persons 60 years old and above by sex and education in Thailand, standardised for age; 2011 to 2016.
Sources: 2011 SOPT, 2014 SOPT and 2016 PCWAS

Figure 3 shows the gradient by education for both sexes based on the prevalence rates in 2016. The education gradient in both sexes is more distinct for IADL and even more so for poor cognition. Depression shows the gradient between the three education level classification but the increase to older ages is not apparent particularly among women. Such age trend is also observable in anxiety among males.

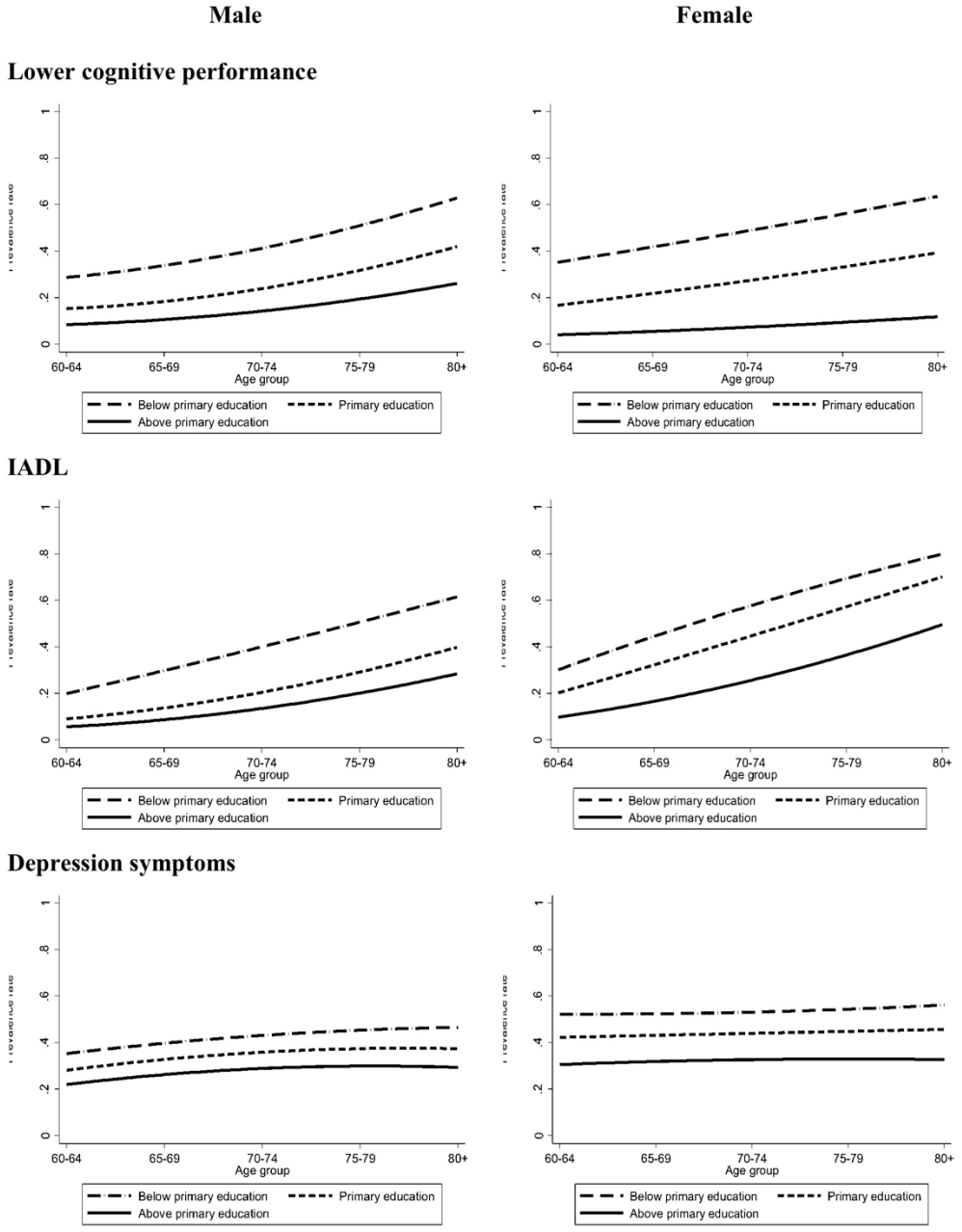

Figure 3: Proportion of the older population with ill-health status by age, sex and education, estimated by logistic regression; 2016.

3.2. Population projections and health-adjusted dependency ratios

The development of prevalence rates for the health statuses across the three survey points do not exhibit a clear trend therefore only the ultimate survey point is used which is from the 2016 PCWAS. The predicted figures from a logistic regression model without education differentials and a model with education differentials are applied to the population projections (Figure 4). The aim here is to extract health-adjusted dependency ratios with reference to projected populations. As this is a ratio that is not differentiated by sex, the application of the populations with ill-health status is presented for the general population.

When education differentials are included as a factor in ill-health prevalence, there tends to be much lower rates compared with the population when no education differential is introduced. This is observable in IADL and poor cognition although, the magnitude of difference for each health indicator is different. Again, the effect of education to depression is minimal.

The proportion of older persons will continuously increase to 2050 given the development of the age structure across time (Table 3). This aspect of population growth leads to the steady increase of the traditional old age dependency ratio. From about 24 older persons for every thousand working-age persons in 2015, this figure will increase to almost 64 older persons in 2050.

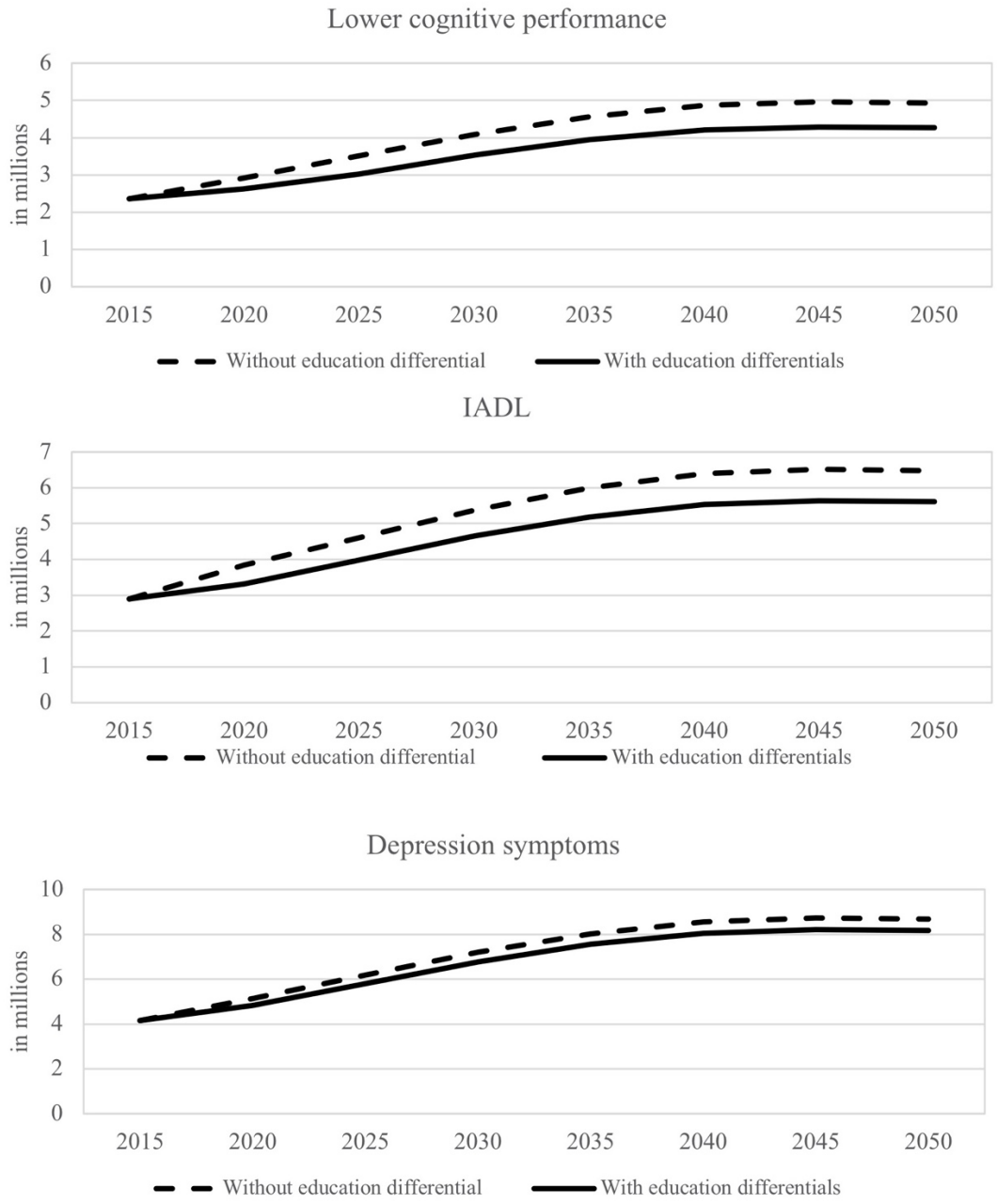

Figure 4: Number of persons 6o years and over with ill health status by type when performing the estimation with and without education differentials; 2015 to 2050.

Table 3. Population projection of broad age groups and old age dependency ratio; 2015 to 2050.

	Population aged 15-59 years (in thousands)	Population aged at least 60 years	OADR
2015	45575	10732	23.5
2020	44858	13281	29.6
2025	43451	15961	36.7
2030	41503	18596	44.8
2035	39477	20733	52.5
2040	37698	22108	58.6
2045	36334	22553	62.1
2050	35111	22434	63.9

Source: Wittgenstein Centre for Demography and Global Human Capital, 2018

Building on the utilisation of the prevalence rates with and without education differentials, the dependency rates based on each health indicator is also surmised. In Table 4, it is observed that the dependency ratios are significantly lower when education differentials are considered in the estimation process. Although depression has higher prevalence rates, the difference between estimates with or without education differentials is lower compared with IADL and lower cognitive performance.

The effect of education differential being part of estimation is substantial for cognition. The dependency ratio for those with poor cognition is 14 per cent lower in 2015 when education differential is utilised than when it is not. This figure in difference becomes almost 30 per cent whereby there are 8 older persons with poor cognition for every 1000 working-age adult along with healthy older adults in 2050 compared with about 11 older persons with poor cognition in the year 2050.

Table 4. Health-adjusted dependency ratio difference when performing estimations with and without education differentials; 2015 to 2050.

Year	Without education differential	With education differential	Difference between ratios (%)
	Lower cognitive performance		
2015	4.3	3.7	14.1
2020	5.8	4.5	22.9
2025	7.1	5.3	24.6
2030	8.4	6.2	26.3

Table 4. Health-adjusted dependency ratio difference when performing estimations with and without education differentials; 2015 to 2050. (cont.)

Year	Without education differential	With education differential	Difference between ratios (%)
2035	9.6	6.9	27.9
2040	10.5	7.5	29.0
2045	11.0	7.8	29.6
2050	11.3	7.9	29.9
	IADL		
2015	5.3	5.0	7.8
2020	6.5	6.1	7.9
2025	7.7	7.2	7.9
2030	9.0	8.4	8.0
2035	10.1	9.5	8.1
2040	10.9	10.2	8.2
2045	11.3	10.6	8.2
2050	11.6	10.8	8.2
	Depression symptoms		
2015	7.6	7.5	2.9
2020	9.3	9.1	2.9
2025	11.1	10.9	3.0
2030	13.0	12.7	3.0
2035	14.6	14.4	3.1
2040	15.9	15.6	3.1
2045	16.6	16.3	3.1
2050	16.9	16.6	3.1

DISCUSSION

As the proportion of older persons in Thailand continues to increase according to projections, there is a commensurate increase in the ratio of old-age persons with ill health. From 2015 to 2050, the people at least 60 years old with issues with their physical, psychological, or cognitive health will augment by double. This will have an impact on healthcare delivery for society because there are various concerns on palliative and long-term care. Delving further into this, it is key to understand the nature of the prospective concerns surrounding health whereby disabilities can be of different forms.

Longer life expectancies are observed but with it is the attention to its quality. The concept of healthy, successful age

advancement then had been integrated into ageing studies. A stereotype is assigned to older persons where they are viewed as being overtly vulnerable to diseases and disabilities leading to higher levels of dependency in most aspects of everyday life[41]. With regard to successful ageing, the characteristics are modified because older persons can be of low risk to diseases, be highly functional in terms of physical, cognitive, and mental standpoint; and be able to engage and to have a prosperous relationship with others. As observed in the results in the current research, the traditional OADR can be highly differentiated to the health-adjusted dependency ratio. When age is the only criteria for being 'old', the prospective capacity of people above 60 years old are ignored. Through this shift in perspective such that later-life adults are considered to be ageing successfully and are functional members of society instead of being 'dependents'. It is worth reiterating though that a great number of successful-ageing studies regarding health are on physical activities and the presence of non-communicable diseases as the data is accessible from medical records, surveys, and clinical studies[42-44]. As noted by Chatterji and colleagues[45], cognitive functioning and health of older persons tend to have sparse data even among high-income countries.

Dependency as a concept has to be viewed from a multidimensional perspective. The dependency ratios based on health dimensions, which are physical, cognitive, and physical, have to be scrutinised as observed in the result as they may bear different levels of burden among the older population. If health rates are held constant, it is observed that cognitive functioning will need increased attention toward the future. The dependency using this health aspect as reference is much higher than the others. Although, the other health aspects would also have to be addressed. Each person can have a range of limitations whereby each one may affect the others i.e. having physical difficulties can affect depressive symptoms or have less cognitive functioning[46]. Understanding therefore the nature of older people's health needs to be integrative while creating space of flexibility to be able to address individual needs in terms of care.

Socioeconomic factors have to be considered also toward the understanding of dependency. Education was observed here to have a positive impact toward better health of the older population which is congruent to the literature[6,39,47]. As presented in the results above, factoring education to standardising prevalence rates of ill health states among the population in their advanced ages creates gradients in dependency. This is a central concern in how a multifaceted perspective of how individuals possessing differences in human capital background can experience the ageing process. The manifestation of the effect of education may be due to the prevailing health-related behaviour, particularly regarding food choice and intake, which can change through time and therefore be transmuted to differences in impact on the older population[43,48]. In relation to this, it has to be cautioned that this effect can be brought on by the composition and structure of the Thai population[15]. They pointed that the circumstance of education gradient along with the expectation with regard to the compositional changes in Thai population may have influence on the decreased absolute number of people with ill health. They further compared it with a study done in Singapore[49] where it had been observed that accounting for education among the old-old population, the projections show more people will have functional disability than when education is not accounted.

CONCLUSION

Dependency of people in older ages has to be understood as a nexus as observed in this paper. Health issues among this population are magnified depending on their socioeconomic characteristics particularly education attainment. The disparity brought on by social gradient has been observed to effect create differences in prospective care needs. In relation to this, advancing in terms of age bears a toll on the overall health of people but this is expressed differently for individuals depending on their contexts. With the data expressing a higher prevalence of cognitive function issue, more studies have to be done to understand this development among older persons in the country in order to prepare for the specific needs that older people may need.

ETHICS APPROVAL AND CONSENT TO PARTICIPAT

The authors extend gratitude to the College of Population Studies, Chulalongkorn University for the permission to use the Population Change and Well-being in the Context of Ageing Societies survey data for the analysis of secondary data. This survey with ethical approval from the institutional review board of Chulalongkorn University (COA No.095/2559).

HUMAN AND ANIMAL RIGHTS

No human and animal experiment was used in this study.

CONSENT FOR PUBLICATION

We would like to undertake that the work of this manuscript is original and has neither been published nor submitted for publication elsewhere. We provide our consent for the publication of this article.

AVAILABILITY OF DATA AND MATERIALS

The dataset used for this study is by the College of Population Studies, Chulalongkorn University.

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CONFLICT OF INTEREST

The authors report no conflict of interest.

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Declared none.

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