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REVIEW

The effect of population aging on health expenditure growth: a critical review

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Abstract Although the consequences of population aging for growth in health expenditures have been widely investigated, research on this topic is rather fragmented. Therefore, these consequences are not fully understood. This paper reviews the consequences of population aging for health expenditure growth in Western countries by combining insights from epidemiological and health economics research. Based on a conceptual model of health care use, we first review evidence on the relationship between age and health expenditures to provide insight into the direct effect of aging on health expenditure growth. Second, we discuss the interaction between aging and the main societal drivers of health expenditures. Aging most likely influences growth in health expenditures indirectly, through its influence on these societal factors. The literature shows that the direct effect of aging depends strongly on underlying health and disability. Commonly used approximations of health, like age or mortality, insufficiently capture complex dynamics in health. Population aging moderately increases expenditures on acute care and strongly increases expenditures on long-term care. The evidence further shows that the most important driver of health expenditure growth, medical technology, interacts strongly with age and health, i.e., population aging reinforces the influence of medical technology on health expenditure growth and vice versa. We therefore conclude that population aging will remain in the centre of policy debate. Further research should focus on the changes in health that explain the effect of longevity gains on health expenditures, and on the interactions between aging and other societal factors driving expenditure growth.

Keywords Population aging · Morbidity · Technology · Health expenditures · Acute care · Long-term care

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Introduction

The societal consequences of population aging, the increasing share of older people in the population, are the subject of extensive public and scholarly debate in many different fields. In health economics, the focus has been largely on the effect of population aging on health expenditure growth (see Payne et al. (2007) for a review). The aging of Western populations stems mainly from decreasing fertility rates, the aging of the post-World War II baby boom generation and longevity gains in general. In Western countries, average health expenditures increased from approximately 5 % of GDP in 1970 to nearly 10 % in 2009 (OECD 2011). The assumed relationship between old age and health expenditure has raised serious concerns about the financial sustainability of health care systems in Western countries. Despite extensive research on the effect of population aging on health expenditure growth, consensus

on its role has not yet been achieved. Instead, two contra posing views coexist (Reinhardt 2003). Some analysts and policy makers view population aging as the major cause of the rapid growth in health expenditure. Others, mainly health economists as well as scholars from other fields, have argued that population aging is largely irrelevant for the growth in health expenditure. An important reason as to why these views are able to coexist is a lack of research combining epidemiological insights on the relationship between health and aging with health economic research. Given that changes in underlying health importantly determine the effect of longevity on health expenditures, insights combining health economics and epidemiological evidence are crucial.

It seems obvious that the relationship between age and health expenditures depends on health. As individuals age, their health generally decreases and this in turn leads to increasing utilization of health care. Less clear, however, is how expected increases in longevity relate to health, and to health expenditures. Epidemiological research on the relationship between longevity improvements and health can be broadly characterized by three hypotheses proposed in the 1980s: expansion, compression, and postponement of morbidity (Kramer 1980; Fries 1980; Olshansky et al. 1991; Payne et al. 2007). The expansion hypothesis assumes that longevity gains will increase the period of time lived with morbidity or disability. The compression hypothesis assumes that this period will shrink. In the postponement, or dynamic equilibrium, hypothesis longevity gains are expected merely to shift the period with morbidity or disability to an older age, while its duration remains constant. Projections of the consequences of aging for health expenditure growth have traditionally been based solely on age, and thus on the implicit assumption that gains in longevity do not alter age-specific risks of disease or poor health. During the last two decades, however, health expenditure models have been developed that do allow for changes in the age profile of health expenditures, most notably by controlling for proximity to death (Zweifel et al. 1999). In general, this line of research has found a much smaller effect of aging on health expenditures than the traditional age-based studies. Yet, most of these models have not made the link between health and longevity gains explicit, and only a few include direct measures of health.

In this paper, we aim to improve understanding of the consequences of population aging for health expenditure growth in Western countries. The paper is organized as follows. First, we start with a conceptual model of health expenditure which relates the effect of age and aging to other determinants on both the individual and the societal level. Second, we discuss how health economic research has developed from age-based models of health expenditure toward models that allow for changes in the association between the risk of death, the risk of ill health and health expenditures. Here we discuss the, often implicit, relationship between longevity and health in these models. Third, we briefly discuss other main determinants of health expenditures, and their possible interactions with aging, to put the effect of aging into context.

Conceptual framework

Figure 1 provides an overview of the different factors that influence individual health expenditures. The figure is based largely on the behavioral model of health service use that was developed by Andersen and Newman (1973). Since these theorists focused on health care use rather than expenditure, we add relevant links to the model, as for instance those between medical technology, wages and prices, and health expenditure. Although not all the elements of the model are relevant for our discussion of the role of aging, the model serves to put aging and the related individual and societal determinants into context. Two main features of the model are especially relevant for a discussion of the role of population aging. First, the classification of individual factors clarifies the relationship between age, health, and health expenditures. Second, the model distinguishes between societal and individual factors that jointly determine the level of individual health expenditures.

The individual determinants are classified into three groups: predisposing, enabling, and need factors. Predisposing determinants reflect the individual's "propensity toward use." They influence the likelihood that one will use health care, without being directly responsible for its utilization. Examples of predisposing factors include age, sex, marital status, co-residence status, socio-economic status, and living and working conditions. Essential for our discussion is the fact that age is classified as a predisposing determinant. That is, age itself is not a reason for seeking health care. Instead, people in different age groups have different types and amounts of illness and consequently different patterns of health care use. The role of age as a predisposing determinant is important, because it suggests that the effect of increases in longevity, or the number of individuals at older ages, depends on the relationship with the underlying need determinants.

These need determinants constitute the reason why an individual, given the presence of predisposing and enabling determinants, seeks the use of health care. The main need determinants are poor health and disability. Health is comprised of various dimensions, e.g., the presence of (chronic) diseases, self-reported health, mental- and physical illness. Disability reflects the way in which poor health limits the ability to perform (instrumental) activities of daily living and mobility. Although health and disability

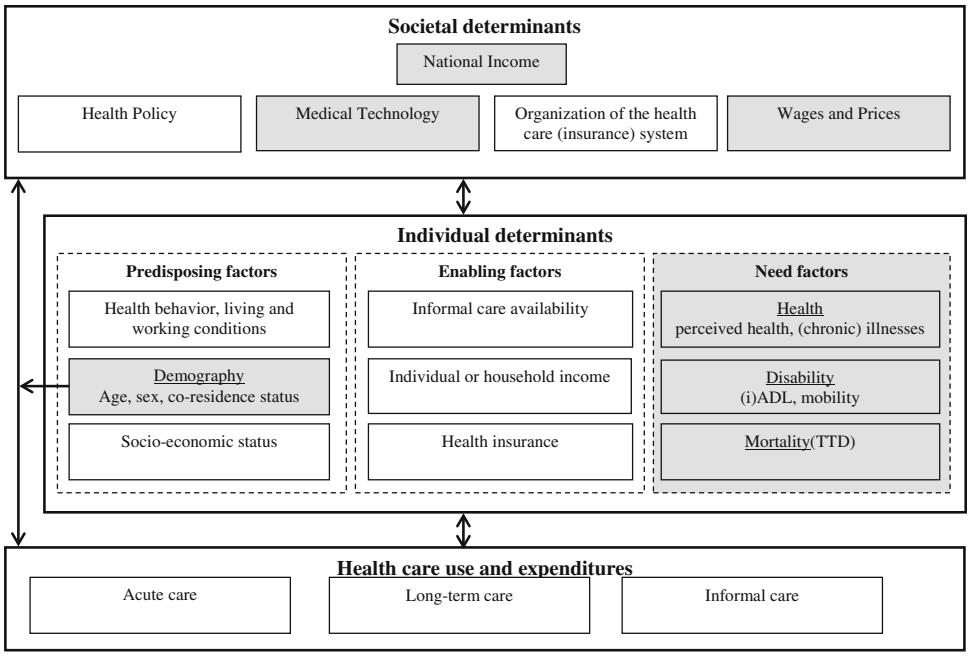

Fig. 1 Conceptual model of individual health expenditures

are related, both determinants have a different relationship to health expenditures. This relationship also differs between types of care, especially between acute and long-term care (De Meijer et al. 2011). Mortality is also included as a need determinant, even though mortality itself cannot lead to health care use, because a large part of aging research in health economics has focused on the role of proximity to death, as a proxy for health, to explain health expenditures (Payne et al. 2007). We relate to mortality as a need determinant rather than a predisposing determinant, because, unlike age, death is a consequence of poor health and not the other way round.

Enabling determinants concern the resources available to satisfy a need regarding health care use. They include the level of health insurance coverage, individual, or household income, and informal care supply. Informal care can serve as a condition or substitute for formal care, particularly in less skilled long-term care (Bonsang 2009). Informal care supply depends largely on the population age composition, which on its turn depends on fertility rates and the number of children, and household composition, as informal caregivers are often children or partners. Population aging is therefore likely to impact future informal care supply. However, the direction and strength of this effect is less clear. On the one hand, future older people are likely to receive less informal care from their children. On the other hand, decreases in the male–female life expectancy gap (OECD 2011), resulting in fewer widowers, might increase informal care from partners. Apart from the issue of informal care supply, other enabling determinants have less direct relevance for the role of aging, and we do not discuss them further in this paper.

At the top of Fig. 1, the societal determinants of health expenditures are shown. In a collectively financed health care system, societal determinants are largely responsible for the level of collective health expenditures, whereas individual determinants are mostly responsible for the distribution of collective health expenditures between individuals (Getzen 2000). Societal determinants influence health expenditures directly and indirectly, through their interaction with the individual determinants of health care use. The societal determinants that play the largest role in health expenditure growth are national income, medical technology, and wages and prices (Reinhardt 2003). Although there is some evidence of cost containment effects of health system characteristics and certain policies (e.g., Wagstaff 2009; OECD 2009), their long run effect seems to be limited given an increasing willingness to pay for health care (Woodward and Wang 2012). The relevance of the societal determinants for this paper lies in their interaction with age and health. Therefore, societal determinants potentially reinforce the effect of population aging, and vice versa.

The determinants shaded in Fig. 1 are those that are discussed more extensively in the remainder of this paper. We believe that this selection captures the most relevant determinants needed for an analysis of the role of aging in health expenditure growth. In the case of individual determinants, these are age, health, disability, and mortality. In the case of societal determinants, these are national income, medical technology, and wages and prices as there is (indicative) evidence that these particular societal determinants reinforce the effect of population aging, or vice versa.

Individual determinants of health expenditure: age, mortality, and health

The impact of age and mortality

Until the end of the 1980s, studies on the consequences of population aging for health expenditure growth were mostly based on the observed relationship between age and average health expenditures per year. This relationship shows a strong increase of health expenditures with age. When cross-sectional age profiles of expenditures are combined with demographic projections, huge increases in health expenditures due to population aging are predicted (Longman 1987; OECD 1988). As pointed out in the conceptual model, age is a predisposing determinant. Therefore, age-based projections are only valid when it is (implicitly) assumed that increases in life expectancy do not change the relationship between age and the onset of health problems. However, studies that explicitly account for the high health expenditures in the final years of life contradict this assumption.

The idea behind the latter studies is that the age profile of health expenditures can be explained by the fact that relatively more people in older age groups are in their final years of life than those in younger age groups. Cost of dying studies have confirmed that health expenditures are considerably higher for decedents than for survivors (Scitovsky 1984; Madsen et al. 2002; Yang et al. 2003; Polder et al. 2006). However, unlike acute care expenditures, long-term care expenditures still increase significantly with age after controlling for the expensive final years of life (McGrail et al. 2000; Polder et al. 2006; Spillman and Lubitz 2000; Yang et al. 2003). The fact that expenditures are largely concentrated at the end of life regardless of the age at death suggests that this will reduce health expenditure growth, as there will be fewer people in the last year of life due to falling mortality rates. Predictions of future health expenditures should account for this.

A more refined way of controlling for the high expenditures near the end of life is offered by time to death studies. Instead of comparing aggregated costs of decedents and survivors by age, time to death studies use individual data to model health expenditures as a function of the time away from death, allowing for in-depth analyses of the effects of approaching death on health expenditures over time. Time to death studies consistently conclude that time to death and not age is the main demographic determinant of health expenditures (e.g., Roos et al. 1987; Häkkinen et al. 2008; Seshamani and Gray 2004; Werblow et al. 2007; Zweifel et al. 1999). For acute care, age has no effect or a negative effect on decedents' expenditures, and only a weak positive effect on survivors' expenditures (e.g., Häkkinen et al. 2008; Werblow et al. 2007). For long-term care, in comparison, expenditures still increase with age, although controlling for time to death diminishes its effect (e.g., Häkkinen et al. 2008; Roos et al. 1987; Weaver et al. 2009; Werblow et al. 2007).

Reconsidering the impact of age and mortality: controlling for health and disability

Cost of dying and time to death studies recognize the role of age as a predisposing determinant in the sense that the age pattern of health expenditures largely reflects increasing mortality rates with age. However, the latter relationship is itself the result of deteriorating health. If mortality is indeed a proxy of morbidity in explaining health expenditures, the concentrated health expenditures observed at the end of life are merely due to a higher burden of disease at the end of life. When mortality approximates health, predictions of the effect of population aging, and specifically longevity gains, are only accurate when longevity gains do not change the relationship between mortality and health. But, as mentioned earlier, epidemiological research suggests that this relationship might not be constant (Kramer 1980; Fries 1980; Olshansky et al. 1991; Payne et al. 2007). In such cases, models are needed that incorporate direct measures of health.

While time to death studies abound, only a few of them explore the relationship between health, disability, and individual health expenditures. The available studies can be divided into three categories. The first category comprises studies that differentiate the effect of mortality by underlying cause-of-death. For example, decedents from cancer and respiratory diseases have significantly higher end-of-life spending than decedents from heart disease, indicating that the precise effect of mortality depends on the specific health problem (Bird et al. 2002; Seshamani and Gray 2004; Wong et al. 2011a), and also on the coexistence of other health problems (e.g., Wong et al. 2011b; Häkkinen et al. 2008). Second, there are studies that use both mortality and general health indicators to explain health expenditures. Dormont et al. (2006) in France, and Shang and Goldman's (2008) study of Medicare in the United States, show that mortality has little impact on health expenditures after controlling for morbidity, confirming that mortality largely approximates the effect of morbidity in health expenditure models. Third, a few studies have analyzed the relationship between health status and cumulative health expenditures over the remaining lifetime. These studies demonstrated that improvements in health lead to longer life expectancy but not to lower health expenditures, in most cases (Lubitz 2005; Wouterse et al. 2011).

Some studies examined the effect of need determinants specifically for long-term care (De Meijer et al. 2009,

2011; Weaver et al. 2009). As in the case of acute care, the effect of mortality turns out to depend on cause-of-death (De Meijer et al. 2011). However, there is also a significant difference: the relationship between age and long-term care expenditures remains, even after controlling for disability and general health. In addition to disability and age, informal care availability has been shown to decrease formal long-term care expenditures.

Predictions of health expenditures growth based on individual determinants (age, mortality, and health)

Different types of expenditure models also lead to different predictions of the effect of population aging on future health expenditures. Predictions from age-based models (models that do not account for mortality or health) implicitly assume that gains in longevity do not influence the age-specific risks of diseases or poor health, and thus adhere to an expansion of morbidity scenario. In contrast, time to death models assume that the high health expenditures during the final years of life shifts equivalently with longevity gains. Thus, mortality-based projections adhere to a postponement of morbidity hypothesis, as the period spent in poor health is assumed to be merely postponed to a later age. Population aging has, therefore, a significantly lower impact on future health expenditures when accounting for mortality instead of age only.

The total annual real growth of health expenditure is, on average, 4 % in Western countries (OECD 2011). Studies on annual growth in health expenditure have found a rate falling roughly between 0.5 and 1.7 % due to population aging without accounting for decreasing mortality rates and a 0.1 and 0.5 % point lower growth rate when accounting for reductions in mortality rates (e.g., Steinmann et al. 2007; Miller 2001; Shang and Goldman 2008; Polder et al. 2006). The extent of the variations in prediction between age-based and mortality models depends on the service under consideration. The difference between age-based and mortality models is particularly large for hospital expenditures and much less for primary care and pharmaceutical expenditures (e.g., Seshamani and Gray 2004; Serup-Hansen et al. 2002; Häkkinen et al. 2008; Kildemoes et al. 2006).

Although mortality models adhere to the postponement of morbidity hypothesis, recent evidence seems to support the compression hypothesis, although not unambiguously (Martin et al. 2010; Christensen et al. 2009; Lafortune et al. 2007; Parker and Thorslund 2007). Despite divergent results, the tendency seems to be that the time spent with (severe) disability remains constant or is shrinking. Population aging has, therefore, a significantly lower impact on future health expenditures in models that take disability into account as compared to those based on only age or mortality.

Few projections of future health expenditure control directly for trends in disability. Manton et al. (2006) and Manton and Lamb (2007) investigated how the decline in disability among older Americans between 1982 and 1999 affected future Medicare costs. Although their estimates are now outdated, they demonstrated that projections extrapolating the recent disability decline accurately approached the actual amount spent. De Meijer et al. (2011) found similar effects of decreasing disability trends for future homecare expenditures in the Dutch population.

Societal determinants: national income, technology, and wages

The previous section showed that population aging, as such, accounts for an annual real growth of health expenditures of 0.5–1.0 %. As total annual real growth in Western countries is on average 4 % (OECD 2011), population aging is, thus, not the only important determinant of health expenditure growth. Societal factors found to be at least equally important are national income growth, technological development, and rises in wages and prices (Burner et al. 1992; Reinhardt 2003; Richardson and Robertson 1999). However, as explained in the conceptual model, there might be strong interaction effects between population aging and these factors. As a result of these interactions, the age profile of health expenditures might change. Given this, we first briefly discuss the main societal determinants, and then turn to their interactions with age and health showing evidence for changes in the age profile of health expenditures.

Societal determinants

In general, income reflects the ability and willingness to pay for health (care). On a national level, income growth is found to be the strongest explanatory factor for health expenditure growth (Newhouse 1977; OECD 2006). The common explanation for the strong relationship between national income and health expenditure is that health is a luxury good: when income grows, individuals want to spend a larger share of it on health care (Wildavsky 1977; Hall and Jones 2007). Although the evidence for this reasoning is quite strong on a national level, it should be noted that income is found to have a very small impact on an individual level (Van Doorslaer et al. 2004; Getzen 2000). This difference in results can be explained by the presence of collective health insurance that makes the price of health care use close to zero at the individual level (Getzen 2000).

Although it is sometimes stated that development of new medical technology is a result of increasing willingness to pay for health, medical progress itself is often mentioned as

the most important driver of health expenditure growth, and particularly of acute expenditures (e.g., Newhouse 1992; Weisbrod 1991). In fact, technological progress has two contrasting effects on health expenditure. It can mitigate expensive care and reduce costs, but it also tends to increase use (Cutler and McClellan 2001; Lubitz 2005; Cutler 2007). In general, the latter of these two effects prevails, resulting in a rise in total health expenditure (Bodenheimer 2005). Although intuitively strong, evidence on the impact of technological progress on health expenditures is relatively scarce. Studies that do explicitly consider technological growth, for example those that look at research and development spending, generally find a strong positive effect on health expenditure growth (Dormont et al. 2006; Goldman et al. 2005; Jones 2002; Okunade and Murthy 2002; Suen 2005; Westerhout 2006).

The relative price of health care is also an important driver of health expenditure growth. Health care tends to be relatively labor intensive and part of this labor cannot be easily substituted by technology, especially in the long-term care sector. As a result, labor productivity in health care tends to develop more slowly compared to other industries. Since health care workers earn an income comparable to that in other sectors, the relative price of health care increases. Although findings vary (Murillo et al. 1993; Murthy and Ukpolo 1994; Okunade et al. 2004), the effect of this so-called Baumol's disease (Baumol 1967) on health expenditure growth tends to be as large as that of population aging (Hartwig 2008).

Interactions

The conceptual model suggests interactions between the individual determinants age and health, and the societal determinants. Although empirical evidence is limited, we discuss indicative findings on three possible interactions. First, one would expect that health expenditures will have a positive effect on life expectancy and/or health. In fact, one of the most important criticisms of the time to death literature has been that it ignores this effect (e.g., Salas and Raftery 2001). However, for long periods of time, the role of health care in decreasing mortality has been found to be small compared to other factors such as nutrition and public health measures (McKeown 1976; Szreter 1988). For recent decades, a much stronger effect of health care on lowering mortality has been found, especially for the older population (Bunker et al. 1994; Mackenbach 1996; Cutler et al. 2006; Mackenbach et al. 2011). Empirical evidence of the effect of increased health spending on health is restricted to disease-specific studies (e.g., Cutler et al. 2008).

Second, because the distribution of health expenditures between individuals is largely determined by health, additional health expenditures or medical innovations are likely to be directed toward groups with relatively poor health. Although there are examples of medical innovations aimed at age groups with relatively small health problems, older people are likely to disproportionally benefit from medical innovations. Goldman et al. (2005) simulated the effects of ten key technologies on health expenditures in the U.S. They found that most of these innovations resulted in a shift of health expenditures to older age groups. Wong et al. (2012) found similar results for the Netherlands. That medical innovations are targeted more at older people also seems to be suggested by the fact that during the last few decades, life expectancy at age 65 rose faster than at other ages (Christensen et al. 2009).

Third, changes in the population composition caused by population aging will influence some of the societal factors. For instance, Murphy and Topel (2006, p. 884) have shown that "aggregate willingness to pay for progress against a particular disease will be highest when the age distribution of the population is near, but before, the typical onset of the disease." Therefore, population aging might increase the demand for collectively financed health care aimed at older age groups. This effect, where population aging results in a larger demand for health care aimed at the older population, resulting in further population aging, has been named the Sisyphus syndrome. Empirical evidence on this phenomenon, however, is limited (Zweifel et al. 2005). Finally, increases in the share of older people can also be expected to result in a further rise in wages for the health care sector (Dixon 2003; Simoens et al. 2005).

Hence, the literature tends to suggest that the influence of societal determinants is not age-neutral, and additional health expenditure is likely targeted at older age groups. As a result, the age profile of health expenditure might steepen over time. Indeed, there is emprical evidence for this steepening effect (e.g., Meara et al. 2004; Dormont et al. 2006; Breyer et al. 2010).

Discussion and conclusion

Aging in perspective

This paper has reviewed evidence on the effect of population aging on health expenditure growth. We have focused on the relationship between improvements in longevity and trends in health, and its consequences for health expenditures. Furthermore, we have put the effect of population aging in perspective by looking at other major societal determinants of health expenditures and their interactions with aging. The paper started with two opposing views: population aging is either the main factor behind the rapid health expenditure growth, or largely

irrelevant for this growth. What has our review of the literature added to these views?

First, evidence from the literature has shown the value of explicitly considering health-related causes of the relationship between age and health expenditures. As discussed in the conceptual model, age is a predisposing determinant that is not directly responsible for utilization of health care. Instead, it is the relationship between age and need determinants such as health and disability that explain the age pattern of health expenditures. Predictions that account for health, either directly or through the variable of mortality as a proxy, tend to find that population aging only moderately contributes to health expenditure growth. The results therefore seem to support the second view. However, the effect of population aging is much stronger for long-term care compared to acute care. In fact, the annual health expenditure growth attributed to population aging is found to be up to 1 %, which is far from trivial.

Second, in discussing the effect of societal determinants on health expenditure growth, the literature has shown that the total annual health expenditure growth in Western countries averages 4 %. National income growth, medical technology, and price and wage rises are the main drivers of health expenditure growth on the aggregated level (Burner et al. 1992; Reinhardt 2003; Richardson and Robertson 1999). However, there is evidence for interactions between population aging and these societal determinants. Whereas the level of collective health expenditure is to a large extent driven by societal determinants, its distribution is largely determined by health and disability. Medical innovations and additional growth in health expenditure are therefore more often targeted at older people, reinforcing the effect of population aging. In a number or studies, a steepening of the age profile of health expenditures has indeed been found.

While the direct effect of population aging is less dramatic than expected by some, policy makers should keep in mind the interaction between population aging, health, income growth, technological developments, and wages/prices. Although health expenditure growth might reflect a collective willingness to pay for health, we have discussed evidence that increased health expenditure is to a relatively large extent beneficial to the older age groups, which are growing in relative size. In a collectively financed health care system, in which a substantial part of health care premiums are paid by the working force population, this might strain inter-generational solidarity. Baicker and Skinner (2011) have found that OECD countries with higher tax burdens in 1979 experienced slower health expenditure growth in subsequent decades. This observation seems to suggest that there are limits to what individuals are willing to pay for collectively financed health care. Policy makers should therefore be selective in what kinds of health care they want to fund by public resources.

The consensus from the literature on the relatively large role of age and disability for long-term care expenditures suggest that prioritizing medical innovations aimed at improvement of quality of life and functioning over those aimed at postponement of death might be a promising approach to contain costs. Medical technology that allows people to remain living at home, even with chronic diseases, might lead to substantial savings in long-term care. In addition, improved functioning could increase labor participation at older ages, and increase the (health care) workforce.

Conclusion

Health expenditures will continue to rise in the coming decades. Although the direct effect of population aging is modest, age and aging remain important factors in the debate on health expenditure growth. Many drivers of this growth interact with population aging, particularly health, national income growth, technological progress, wages and prices. Future health expenditure is likely to be targeted more toward the older population. If increases in health expenditure reflect an increasing willingness to pay for health and solidarity, its growth may not necessarily be a problem. However, the larger extents to which health expenditure will be used by older people, in combination with a financing system that distributes costs over the entire population, can strain inter-generational solidarity. Therefore, population aging will remain in the centre of policy debate. Further research should focus on the changes in health that explain the effect of longevity gains on health expenditures, and on the interactions between aging and other societal factors driving expenditure growth.

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