

# Wind of Change? Attitudes towards Aging and Use of Medical Technology

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**Abstract:** Shifts in demographic developments have led to changed needs and requirements in healthcare. Rising life expectancy and improved medical healthcare enable a more independent and healthier lifestyle of (older) persons, but also changes expectations and perceptions of aging, and health-supporting technologies. Knowledge about attitudes towards aging, medical assistive technologies, and impacting user factors (especially age and health status) is limited with regard to a broad sample of participants. In the present study ( $N=585$ ), we therefore examined in an online-survey current attitudes towards aging and quality of life in older age, as well as perceptions and acceptance of health-supporting technologies, taking age and health status as user factors into account. Results revealed significant effects of age and health condition on the perception of life quality in older age. In addition, positive perceptions of aging, technology acceptance, as well as benefits and barriers were significantly influenced by the respondents' age. In contrast, health status significantly affected the negative perceptions of aging. Under impacts of age and health condition as user factors, results of the study allow a deeper understanding of changing patterns of perceived aging and prevailing opinions regarding acceptance of medical technology.

## 1 INTRODUCTION

The increasing aged population represents a big challenge to the feasibility and sustainability of current health care. Higher proportions of older people in need of care, declines of birth rates, and shortage of care personnel constitute enormous economic, political, and in particular social strains for the society (Pickard, 2015; Deusdad et al., 2016).

In Germany in 2014, these demographic shifts were characterized by a fifth of the population aged above 65 years and more than a tenth of the population aged above 75 years of age. Moreover, as almost two thirds of people aged beyond 90 years were in need of care, the situation of not enough people being able to pay and care for seniors grows more acute than ever before (Haustein et al., 2016).

Ubiquitous diffusion of assistive technologies offers the potential to facilitate the work of care personnel as well as to support older people in their everyday life, enabling a largely autonomous living in their home environments. Besides care-related challenges, the longer life expectancy of people – due to better medical health care – leads to growing interests in a healthier and self-determined living. Here, assistive

technologies offer opportunities to support health-care by reminding and emergency detecting functions (Rashidi and Mihailidis, 2013), enabling digital social interaction (Delello and McWhorter, 2017), or facilitating everyday life, using automated functions, like for example documentation of measurements and smart home functions (Demiris et al., 2008).

In the context of aging, research has long focused on the deficit approach, which links the process of getting older to negative aspects, such as loss of mental and physical integrity, dwindling interests, and generally declining skills. However, according to Baltes (1987) aging is rather a process of losses *and* gains. For example, aging is associated with higher optimism, higher interpersonal trust, and well-being (Poulin and Haase, 2015). In addition, the older people are increasingly interested in a healthy living, in an active shaping their lives, and are more open-minded towards technology with its assisting devices and functions (Smith, 2014).

Allowing for the potential technological support and changes taking place with regard to age and aging, it is therefore of high interest to empirically investigate a broad sample of (older) participants, having experiences with chronic illnesses. Thus, in this

study we examine people's attitudes towards aging and their perceptions of medical assistive technology in relation to their demographic variables of age and health status.

## 2 RELATED WORK

This section summarizes the current state of the art, starting with the research on perceptions of aging, which is followed by an overview of diverse user groups' acceptance of medical assistive technology. Afterwards, the aim and underlying research questions of the current study are briefly described.

### 2.1 Age and Perception of Aging

Aging is "*characterized by a progressive loss of physiological integrity, leading to impaired function and increased vulnerability to death*" (López-Otín et al., 2013, p.1194) and affects all aspects of human life. It is also associated with higher risks of chronic illnesses and, thus, with higher probability of a need for medical interventions or care (Jaul and Barron, 2017).

Yet, some negative effects of aging can be mitigated by technology: For example, smart homes and Ambient Assisted Living offer emergency assistance and autonomy enhancement, increase comfort, and contribute therefore to aging in place (Rashidi and Mihailidis, 2013). Thereby, tele-health interventions can increase the quality of care in older adults, and also increase health and social functioning (Gellis et al., 2012). Age-inclusive serious games can support staying fit, contributing thus to overall well-being (Brauner et al., 2013). Yet, attitudes and stereotypes shape how aging is perceived as a societal challenge, how individuals perceive and deal with their aging, and probably also their relationship towards assistive technologies. Kleinspehn-Ammerlahn et al. (2008) studied self-perceptions of aging and found that most people feel younger than their chronological age, but that these differences and satisfaction with aging decline with increasing age. Furthermore, Kotter-Grühn and Hess (2012) showed that aging stereotypes significantly influence the self-image and the perception of aging, which – in turn – affects attitudes and behaviors. For example, age is typically linked to lower self-efficacy in interacting with information and communication technology (Schreder et al., 2013), which yields lower use, lower ease of use, and lower performance of older adults. On the other hand, studies found that older adults are enthusiastic about learning new technologies, as long as these are designed responsibly and aligned with interests, values,

and (cultural) expectations of the users (e.g., Heinz et al., 2013; De Schutter and Vanden Abeele, 2010; Knowles and Hanson, 2018). In fact, recent studies show that the use of technologies among older adults is increasing (Smith, 2014).

Aging, attitudes towards aging and age stereotypes have been studied as intensively as the requirements and handling of technology by older people. Yet, there is a research gap in the interconnection of these areas and in the question of how the perception of medical assistive technologies is shaped by age, perceptions of aging, or chronic illnesses and care demands, in particular.

### 2.2 Medical Technology Acceptance

Technology acceptance of future users is an indispensable prerequisite for a sustainable adoption and everyday use of innovative technologies (Rogers, 2010). In the last years, research on acceptance of medical technologies found and confirmed that acceptance depends on perceptions of technology-related benefits and barriers. Considering numerous studies in this research area, assistive technologies were mostly assessed favorably, while technology benefits of a more independent and autonomous living, an increased feeling of safety as well as an enabled longer staying at the own home for (older) people in need of care are especially appreciated (Gövercin et al., 2016; Peek et al., 2014).

In contrast, there are also some barriers accompanying the perceived benefits of using assistive technologies, which have the potential to impede the integration of such into peoples' living environments: These barriers mainly include fears of privacy violations (Peek et al., 2014; Wilkowska, 2015), and also feelings of surveillance and isolation (Beringer et al., 2011; van Heek et al., 2018) in terms of a substitution of human contact by technology. In addition, research showed that specific type of technology (Himmel and Ziefle, 2016) and application context (van Heek et al., 2016) impact the acceptance patterns.

With regard to non-technical parameters, user diversity and specific requirements of different stakeholders have been proven to influence the technology acceptance. Previous research showed differences in technology perception with regard to gender (Wilkowska and Ziefle, 2013), health status (Klack et al., 2011), or experience with care (van Heek et al., 2017, 2018). Due to the demographic changes it is thus of importance to analyze age and state of health (and their interaction) as impacting user factors.

In previous research, age has been frequently analyzed as influencing demographic variable in the con-

text of technology perception and acceptance (e.g., Beringer et al., 2011; Wilkowska and Ziefle, 2013; Wilkowska, 2015). Compared to that, it is still quite unclear whether perceptions of benefits and barriers are impacted by people's health status and to what extent it is related to perceptions of aging. Further, interactions between age and health status and their influence on medical technology acceptance have not yet been investigated for a broad sample of older adults, who suffer from chronic illnesses.

### 2.3 Objectives of the Study

The objective of the present study was therefore to examine individuals' current perceptions of aging and their attitudes towards the use of medical technologies, which are meant to support seniors or persons with chronic diseases in their everyday duties. The empirical research was pursued using an online-questionnaire and special focus was directed to persons of different ages and states of health. Details about the applied method and the design approach are presented hereafter.

## 3 METHOD

Drawing from prior research (Wilkowska and Ziefle, 2013; Schomakers et al., 2018), an online-survey was conceptualized in order to reach a large sample of participants. The study focused on two main issues: The first focus was on individuals' perceptions of criteria which are important for a high quality of life in older age, and their opinions regarding different effects of aging itself. The second main focus was on attitudes towards use of medical technology in health-related contexts to support persons with health problems or older and frail adults in their everyday duties.

### 3.1 Online-survey

The questionnaire used in this study was divided in three main parts: In the *first* part, we collected information about the participants' socio-demographic profiles, gathering data regarding their age, gender, professional background, housing circumstances as well as general state of health, subjective vitality (Ryan and Frederick, 1997), and (non-)presence of chronic diseases. In this section of the survey, participants also reported, whether they had experience with health-supporting devices in their daily lives and answered questions about their general technical self-confidence according to Beier (1999).

The *second* part of the survey focused on perceptions of criteria which are related to a high quality of life in old age (QL), like for example competent medical care, self-supply in daily life, and consistent social network (all items of this scale are summarized in Figure 2). Participants assessed the respective items on a 6-point Likert-scale ranging from 1 ("I do not agree at all") to 6 ("I fully agree"). The scale of quality of aging in old age reached a satisfactory internal consistency of Cronbach's alpha  $\alpha=.85$ . In addition, in this part of the survey participants' opinions regarding positive and negative effects of aging were gathered, using similar response format; Table 1 contains some examples of the corresponding items. The scales for both *positive* and *negative* effects of aging reached very high internal validities ( $\alpha_{\text{pos}}=.93$ ;  $\alpha_{\text{neg}}=.95$ ).

The *third* part of the survey focused on participants' perceptions of benefits and challenges applying to the use of health-supporting technologies. A general attitude towards medical technology (AtMT) has been collected, using following items:

- "For me, using medical technology makes sense."
- "I do not want to use medical technology."
- "I can imagine the use of medical technology."

The participants could express their (dis-)agreement regarding these statements on a 6-point Likert-scale. After re-coding of the negatively poled second item, the AtMT-scale reached a satisfactory item homogeneity of  $\alpha=.74$  with a minimum of 3 and maximum of 18 possible points. Moreover, participants were asked to evaluate possible reasons **for** and **against** the use of medical technologies. Thereby, the 6-point Likert-scale (1=full disagreement to 6 = full agreement) was used once again. Items used as perceived pros and cons for the use of health-supporting technologies are explicitly listed in the results section.

Participants were recruited through a professional survey panel platform, which enabled to gather a representative sample of German participants. Participants were paid for participating by the survey panel's institute. The sample's composition and its characteristics are described in more detail in subsection 3.3.

### 3.2 Research Approach

In line with the principle of responsible research and innovation, this study aimed at the reflection of current opinions about the process of aging and the associated life circumstances as well as perceptions of the use of medical technologies as one possible solution or support for autonomy and independence in older age. To pursue this objective, following research variables were chosen for the statistical analyses:

Table 1: Item examples for the scales of positive (PEoA) and negative effects of aging (NEoA).

Positive Effects of Aging	Negative Effects of Aging
"In my opinion, seniors (today)... ...are more mobile and independent than 20 years ago." ...can maintain their health with lots of physical exercises and careful nutrition." ... can cope better with adversity through his/her own experience." ...have much more time for things they always wanted to do." ... have to keep up with the latest developments in order to stay up to date."	"I'm afraid that in old age... ... I'll be a burden to my family." ... my dignity could be severely compromised (e.g., in case of severe illness)." ... my cognitive abilities will shrink." ...I would be less mobile due to health restrictions and, therefore, socially more isolated." ... I have more to do with medical equipment than with other people." ...I depend on others."

As *independent variables*, participants' *age* and *health status* are taken into account. To understand potential differences in the perceptions of diverse concepts of aging, it is useful to ask groups of persons with various amounts of life experience. Therefore, we divided the sample into three age groups: young (< 40 years,  $n=201$ ; 34%), middle-aged (40–59 years,  $n=223$ ; 38%), and seniors ( $\geq 60$  years,  $n=161$ ; 28%). As it is known from previous research (e.g., Klack et al., 2011; Wilkowska, 2015), the state of health can significantly influence perceptions of the concerned persons. In our statistical analyses we therefore additionally examined, whether suffering from chronic disease has an impact on the respondents' opinions. With regard to the health status, 31% of our participants reported to be healthy (H) and 61% of them declared to suffer from chronic illnesses (CI), like for example cardiac arrhythmia, Crohn's disease, thyroid cancer, asthma, anorexia, multiple sclerosis, and much more.

Aspects considered *dependent variables* in this study applied to aging and use of medical technology, and are summarized as follows:

- Quality of life in old age (QL): A minimum of 9 and maximum of 45 point could be achieved.
- Positive effects of aging (PEoA): Respondents could reach between 11 and 66 points.
- Negative effects of aging (NEoA): This scale ranged from minimum 13 to maximum 78 points.
- Attitude towards medical technology (AtMT) which reached between 3 and 18 points.
- Perceived benefits for the use of health-supporting technologies (pros).
- Perceived challenges for the use of health-supporting technologies (cons).

The research design is presented in Figure 1.

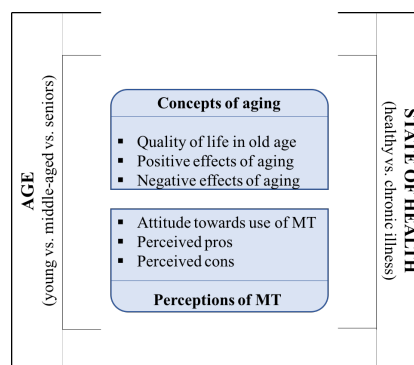


Figure 1: Research design of the present study (MT = medical technology).

### 3.3 Participants

The sample of this study intended to cover a broad spectrum of the German population, including young, middle-aged, and old individuals with and without chronic conditions, with different life experiences, education levels, professional backgrounds, as well as persons with various attributions of a general technical self-confidence and levels of experience with the use of medical equipment.

This study collected and analyzed data of  $N=585$  participants, ranging in age between 16 and 84 years ( $M=47.2$ ;  $SD=16.6$ ) and 48% of them were female (52% male). As the highest educational levels, participants reported to hold an academic degree (21.5%) and 35.7% completed an apprenticeship. Over 19% of the sample reported to hold a university entrance diploma, and 23.6% a secondary school certificate. Less than half of the sample (44.3%) reported to use and have experience with health-supporting devices in everyday life, like for example with blood pressure meters, blood sugar meters, heart rate monitors, wheeled walkers, and activity monitors.

Different professions were represented in the sample, including engineers, teachers, physiothera-

pist, economists, psychologists, IT-managers, self-employed businessmen, technicians, caterers, and many more. About 65% of the respondents reported to live together with at least one other person or family, while 35% used to live alone. Choosing statements with regard to the financial situation, 45% of the sample declared "I have to count every penny, but I make ends meet", 46% stated that they're doing relatively well, and around 9% of them reported that they lack nothing in financial terms.

## 4 RESULTS

For statistical calculations of the influence of independent variables on perceptions of aging and use of medical technologies, we executed (multivariate) analyses of variance [(M)ANOVA] to examine differences between the age groups (the significance of omnibus F-Tests was taken from Pillai values) and T-Tests for verification of differences between the groups of various states of health. The parameter partial eta squared ( $\eta^2$ ) was calculated for effect sizes according to Cohen (1988). For continuous variables, Pearson's product-moment correlation coefficients ( $\rho$ ), and for dichotomous variables Spearman's rank correlation coefficients ( $r_s$ ), were calculated. For descriptive analyses, the means ( $M$ ) and standard deviations ( $SD$ ) are reported in the following. The level of statistical significance ( $p$ ) was set at the conventional level of 5%.

### 4.1 Concepts of Aging

In the first step of statistical analyses, we examined influences of the independent variables, i.e., age and state of health, on perceptions of quality of life in old age and on positive and negative effects of aging.

#### 4.1.1 Quality of Life in Older Age

An univariate analysis of variance revealed a significant effect of *age* on the specific aspects, accounting for a high quality of life. The respondents of the three age groups differed especially regarding competent medical care [ $F(2,581)=3.9, p=.021$ ], independence [self-supply in daily life:  $F(2,580)=12.7, p\leq.001$ ; not being a burden:  $F(2,580)=30.4, p\leq.001$ ], mobility [ $F(2,581)=4.7, p=.009$ ] and social involvement [social network:  $F(2,581)=3.5, p=.030$ ; access to current information:  $F(2,579)=11.7, p\leq.001$ ]. Figure 2 pictures these differences. Generally, from the descriptive results it can be seen that assessments of aspects, accounting for high life quality in old age reached

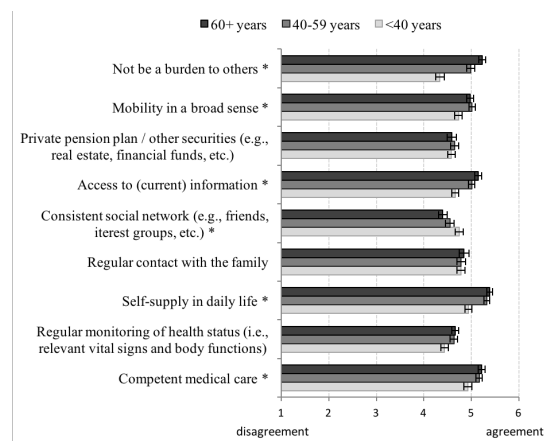


Figure 2: Effect of age on aspects accounting for high life quality in old age [significant differences between the age groups are marked with an asterisk (\*)].

high means in all age groups. Nevertheless, there was a certain pattern in it, which recurred in almost every significantly differing aspect: While in most cases the youngest age group reached the lowest mean values, the senior age group agreed most with the aspects, which were associated with high quality of life.

In addition, the effect of *health status* was examined in this context and exposed significant differences between healthy and chronically ill persons regarding following criteria of life quality:

- competent medical care [ $T(580)=-4.5, p\leq.001$ ]: thereby, chronically ill persons (CI:  $M=5.2, SD=1$ ) valued this aspect significantly more than healthy individuals (H:  $M=4.8, SD=1.1$ );
- self-supply in daily life [ $T(579)=-2.2, p=.027$ ], which was higher valued in CI ( $M=5.3, SD=0.9$ ) than in H ( $M=5.1, SD=1$ ); and
- not being a burden to others [ $T(579)=-2.5, p=.012$ ], where – again – chronically ill persons ( $M=4.9, SD=1.2$ ) desired this aspect more than healthy ones ( $M=4.6, SD=1.2$ ).

Figure 3 shows the main effect of the health status.

#### 4.1.2 Positive and Negative Effects of Aging

In the next step, in a multivariate analysis of variance influences of age and health condition were examined, taking positive and negative effects of aging into account. The statistical calculations revealed main effects of both age [ $F(4,1156)=9.6, p\leq.001, \eta^2=.03$ ] and health status [ $F(2,577)=34.8, p\leq.001, \eta^2=.11$ ].

The *age* differences in perceptions of positive aspects of aging are shown in Figure 4 (top): The oldest respondents in the sample scored with the highest mean values in this regard, demonstrating that

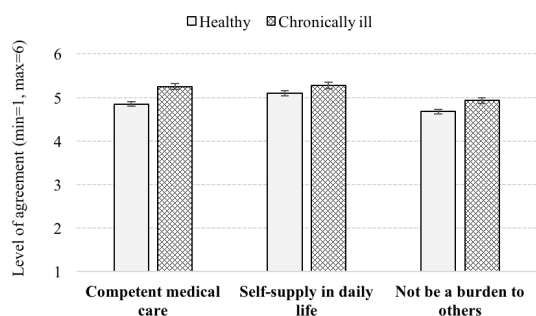


Figure 3: Effect of health status on aspects accounting for high life quality in old age.

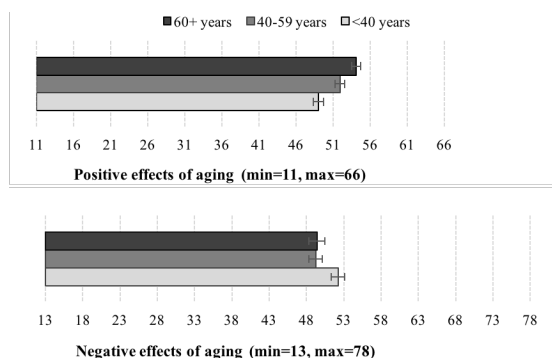


Figure 4: Influence of age on positive (top) and negative (bottom) effects of aging.

they are the most positive with respect to the process of growing older among their younger counterparts. Post-hoc comparisons using the Tukey HSD test indicated that the mean score for young age group ( $M=49$ ,  $SD=8.8$ ) was significantly different from the one of the senior age group ( $M=54.1$ ,  $SD=6.7$ ) and the middle-aged age group ( $M=51.9$ ,  $SD=10.1$ ); the latter two differed significantly too. This result is also mirrored in the perceptions of the negative effects of aging (see Figure 4, bottom), where the youngest participants ( $M=52.2$ ,  $SD=12.9$ ) showed significantly higher values than the older ones (middle-aged:  $M=49.3$ ,  $SD=15$ ; seniors:  $M=49.4$ ,  $SD=12.5$ ).

The resulting effect of *health condition* on PEOA and NEOA is depicted in Figure 5, whereby the explicit differences on the between-subject level were much evident for perceptions of negative [ $F(1,583)=63.2$ ,  $p \leq .001$ ,  $\eta^2=.01$ ] than for positive effects of aging [ $F(1,583)=1.8$ , n.s.]. In terms of content, this means that persons with chronic illness ( $M=54.8$ ,  $SD=12.7$ ) were significantly more pessimistic with respect to the process of growing older than the healthy individuals ( $M=46.3$ ,  $SD=13.4$ ). Furthermore, no interaction effect of age and health was found in the context of positive and negative perceptions of aging.

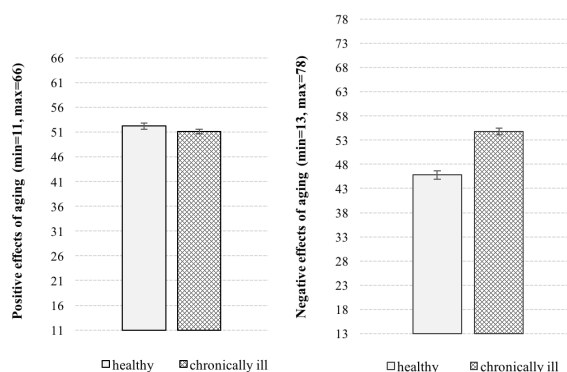


Figure 5: Influence of health condition on positive (left) and negative (right) effects of aging.

## 4.2 Perceptions of Medical Technology

The second main objective of this study was to gain knowledge about the currently prevalent opinions regarding deployment of health-supporting technologies. In this section we analyze effects of age and health condition in this context: We firstly examine influence of these factors on a general attitude towards the use of medical technology (MT), and observe it afterwards for the perceived pros and cons.

### 4.2.1 General Attitude Towards MT

An univariate analysis of variance revealed that *age* significantly affects the attitude towards the use and the meaningfulness of medical technology [ $F(2,573)=5.7$ ,  $p=.004$ ,  $\eta^2=.02$ ]. According to the effect size the effect was small, but it is easy to see in Figure 6 that both older age groups of participants (middle-aged:  $M=14.3$ ,  $SD=3$ ; seniors:  $M=14.2$ ,  $SD=2.7$ ) manifested higher values on the scale than the young age group ( $M=13.4$ ,  $SD=2.9$ ).

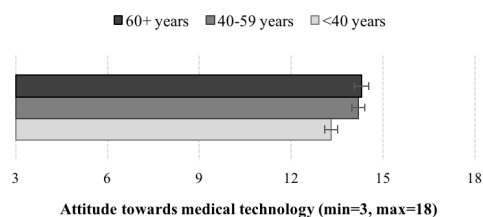


Figure 6: Influence of age on general attitude towards medical technology (AtMT).

*Health status*, on the other hand, did not significantly affect attitudes to the health-supporting technology [ $F(1,573)=2.9$ , n.s.] and there was no interacting effect of age and health status, either [ $F(2,573)=0.7$ , n.s.].

#### 4.2.2 Reasons For the Use of MT (Pros)

There are many benefits resulting from the use of eHealth technologies which are supporting frail persons in their everyday life. In this section, we examine if participants' opinions regarding these perceived pros differ depending on their age and state of health.

For this purpose, in the statistic analysis univariate ANOVA was calculated for benefits which are depicted in Figure 7. The three *age groups* reached quite high average values – a result that shows that there was a high consensus about the many advantages of eHealth technology. The means mostly did not differ significantly between the age groups, excepting the opinion that MT provides an added level of security [ $F(2,575)=4.5, p=.012$ ] and its measurement is reliable [ $F(2,575)=3.8, p=.023$ ]. Regarding these aspects, the young age group was on average less convinced about these benefits in comparison to the both older age groups.

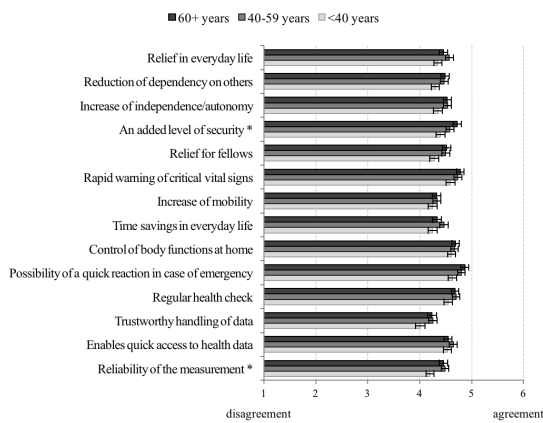


Figure 7: Means in the age groups regarding perceived reasons for the use of medical technology [significant differences are marked with an asterisk (\*)].

If considering these opinions between persons with and without *chronic conditions* significant differences resulted for similar aspects: reliability of the measurement [ $T(574)=-2.1, p=.031$ ], regular control of body functions at home [ $T(574)=-2, p=.043$ ], and an added level of security [ $T(574)=-2.3, p=.024$ ].

As depicted in Figure 8, the differences were quite small. Though, the individuals with chronic illnesses saw in each of these perceived benefits a significantly higher value in comparison to the healthy persons.

#### 4.2.3 Reasons Against the Use of MT (Cons)

Eventually, the impacts of age and health condition were examined regarding challenges associated with the use of eHealth.

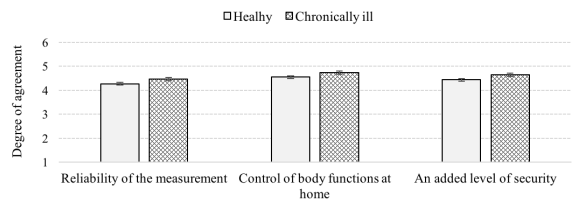


Figure 8: Means in groups of healthy and persons with chronic illness regarding reasons for the use of medical technology.

In contrast to the pro-arguments presented above, statistical analyses revealed major influence of *age* on multiple contra-arguments: doubts about the effectiveness [ $F(2,575)=10.7, p\leq.001$ ], possibility of unauthorized access to personal health records (PHR) [ $F(2,575)=4.8, p=.008$ ], stigmatization by the visibility of disease [ $F(2,575)=5, p=.007$ ], technology reminds of disease [ $F(2,575)=4, p\leq.018$ ], technology is hard to operate [ $F(2,575)=7, p\leq.001$ ], the proportion of technology is too high [ $F(2,575)=6.2, p=.002$ ], dependence on technology [ $F(2,575)=5.1, p=.006$ ], lack of confidence in the technology's functionality [ $F(2,575)=10.1, p\leq.001$ ], lack of confidence in the technology's accuracy [ $F(2,575)=7.8, p\leq.001$ ], invasion in personal privacy [ $F(2,575)=6.6, p=.001$ ], and isolation [ $F(2,575)=4.8, p=.009$ ]. In fact, the

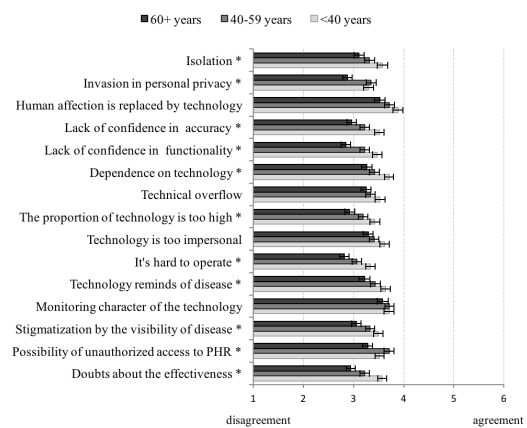


Figure 9: Means in age groups regarding reasons against the use of medical technology (significant differences are marked with an asterisk (\*)).

perceptions of disadvantages are overall rather reluctant. However, looking at Figure 9 which shows the mean values in the respective age groups, similar pattern can be observed almost without exception. On average, the youngest age group reached in almost all cases the highest values regarding the perceived challenges, followed by the means of the middle age group. In contrast, the senior age group disagreed with these cons – and this was evident through means lower than the middle of the scale – and reached al-

ways the smallest values compared to the participants of the both younger age groups. This result showed a quite high acceptance of eHealth technology among the older part of the population. Furthermore, healthy persons and individuals with chronic illness did not differ with regard to the reasons against the use of medical assistive technology. Statistical verification by means of T-Test for independent samples brought no significant effects for these groups.

### 4.3 Correlative Relationships between the Research Variables

In the final step of statistical analyses, correlative relations between the research variables were performed to get a holistic overview over the study data. To do so, scale values were formed for the perceived pros and cons of the use of medical technology (pros:  $\alpha=.96$ ; cons:  $\alpha=.95$ ). The outcomes are summarized in Table 2.

Pearson's correlation coefficients showed clearly that the factor age was significantly connected to almost all dependent variables of the present study. Even when the associations were not very strong, the outcomes indicated that the older the respondents, the more inclined were they to aging and the related circumstances of life (QL:  $\rho=.14$ ,  $p\leq.001$ ), and the more positive was their attitude towards aging ( $\rho=.23$ ,  $p\leq.001$ ) and medical technology ( $\rho=.16$ ,  $p\leq.001$ ). Also, with increasing age the perceptions of arguments pro using medical technology were more affirmative ( $\rho=.10$ ,  $p=.021$ ), while arguments against its use were more refusing ( $\rho=-.15$ ,  $p\leq.001$ ).

Correlations regarding the respondents' health condition, and in particular the presence of a chronic disease, indicated that individuals suffering from chronic illness tend to be more affirmative to the negative effects of aging ( $r_s=.32$ ,  $p\leq.001$ ), but on the other side also more positive towards medical technology ( $r_s=.10$ ,  $p=.014$ ) than healthy persons.

In addition, the correlative analyses confirmed strong interrelations between the research variables: For example, there was a very strong positive correlation between perceptions of quality of life and positive effects of aging ( $\rho=.72$ ,  $p\leq.001$ ). Affirmative attitude towards life quality was also strongly positively connected to the perceived pros of the use of MT ( $\rho=.64$ ,  $p\leq.001$ ) and to the general attitude towards MT-deployment ( $\rho=.52$ ,  $p\leq.001$ ). In contrast, the perceptions of reasons against the use of health-supporting technology (cons) correlated moderately with the scale of negative effects of aging ( $\rho=.38$ ,  $p\leq.001$ ) and, correspondingly, with the attitude towards medical technology itself ( $\rho=-.40$ ,  $p\leq.001$ ).

## 5 DISCUSSION

The aim of the presented study is to reflect current opinions on two significant trends that increasingly affect and concern aging societies – especially most populations in the industrial countries. The first trend is the ever growing proportion of seniors in populations that has been rising sharply and becoming more and more a socio-economic burden to the country. The second is pervasive computing in the domestic environments and thus the private spheres of the residents, which is not only progressively miniaturized, complex, mobile, sophisticated, and unobtrusive, but which also increasingly covers health-related fields, with the potential of systematic monitoring of bodily functions. These two crucial trends gave rise for this study and were observed in the German population. We discuss these issues in the following, taking the previously presented findings into account.

### 5.1 The Bright and Dark Side of Aging

The long-term challenge of a relentlessly aging population is a well-known phenomenon and is intensively discussed in scientific circles from various points of view (e.g., Uhlenberg, 2009). The fiscal burden connected to this phenomenon is, thereby, not only associated with economic issues due to costs arising from the growing public pension system (Bloom et al., 2011), but there are also huge costs accounting for provision of healthcare to the seniors, as with age the need for medical care increases sharply (Bosworth and Burtless, 1998).

The resulting consequences and aspects, which have a direct impact on daily life, also increasingly occupy people's minds. Perceptions of aging and the associated circumstances have undergone a transformation at least since the beginning of the 21<sup>st</sup> century. In these changing times, not only the thinking but also behavior of people intensively changes with the long-term aim for 'aging well'. According to Kotter-Grühn et al. (2009), satisfaction with one's own aging and feeling young are indicators of positive well-being in late life. It was also found that negative self-perceptions of aging as associated with physical losses might impair health-related strategies that are important for maintaining a healthy lifestyle (Wurm et al., 2013). According to the presented results, a higher consciousness of a variety of aspects for a high quality of life in old age is necessary: There is need for health-related and financial security, for social life, and contact with family but especially autonomy and independence in daily life reached in the queried sample the highest mean values. Even though all the ex-



Table 2: Pearson's correlation coefficients between the research variables [Spearman's  $r_s$  for health condition: healthy=1, chronically ill=2; level of significance: \* $p \leq .05$ , \*\* $p \leq .01$ , \*\*\* $p \leq .001$ ].

	QL	PEoA	NEoA	AtMT	Pros	Cons
Age	<b>.14***</b>	<b>.23***</b>	-.02	<b>.16***</b>	<b>.10*</b>	<b>-.15***</b>
State of health	<b>.09*</b>	-.02	<b>.32**</b>	<b>.10*</b>	.06	.01
Quality of life in old age (QL)	–	<b>.72***</b>	<b>.27***</b>	<b>.52***</b>	<b>.64***</b>	-.02
Positive effects of aging (PEoA)		–	<b>.11**</b>	<b>.49***</b>	<b>.62***</b>	<b>-.09*</b>
Negative effects of aging (NEoA)			–	<b>.13**</b>	<b>.25***</b>	<b>.38***</b>
Attitude towards medical technology (AtMT)				–	<b>.63***</b>	<b>-.40***</b>
Reasons for the use of MT (Pros)					–	<b>-.17***</b>
Reasons against the use of MT (Cons)						–

amined aspects were judged approvingly for a good life quality, basically the senior age group perceived these aspects as significantly more important than the young age group. A unique exception is related to a consistent social network. Hereby, the younger part of the population attributes significantly higher relevance to the social interaction than the older one. This is most probably a quite recent phenomenon emerging from the use of social media and social platforms in the last years. However, the conclusion that social interaction is more important for younger than for older persons can be misleading, given the different concepts of what is meant with "social network" for the persons concerned. As opposed to younger people, older generations did not grow up with technology that enables intensive social contacts – even when only in a virtual form – with peers and family. What makes it even more difficult is the fact that getting older also means to be tormented by many losses: Part of the family members and friends may have died by then, and building up new friendships is no longer self-evident nor easy. In consequence, older people feel increasingly isolated or perceive this state generally as unpleasant or frightening. It is therefore conceivable that, for seniors, the idea of maintaining social contacts completely differs from the one of younger generations.

Surprisingly, these generation differences concern also the desire of being no burden to others. One could expect more consensus about this aspect of aging well among the participants, but according to the results respondents of the senior age group attach significantly more attention to their independence and are much more willing to make efforts to not be a burden to others than their younger counterparts. These outcomes differ from earlier research in this context (e.g., Wilkowska and Ziefle, 2013). In addition, opinions differ depending on the current health condition. In order to reach a high life quality in old age, persons with frail health or suffering from chronic illnesses attach considerably higher importance to a competent medical care, self-supply and autonomy in everyday

life than individuals without any health-related problems. Apparently, it is the personal relevance of the issue (i.e., getting older and/or suffering from chronic illness) which makes people perceive their circumstances more positively and to be more open-minded about actively approaching possible solutions.

Because the results refer to the German population, it remains an interesting question whether these differences regard rather to a changing attitude due to an easier access to various possibilities of health care and medical support, or, whether these are culturally shaped opinions.

## 5.2 The Interplay between Aging and Use of Medical Technologies

Drawing from the present research approach, this study makes evident that a positive attitude towards the changes caused by aging comes along with a more optimistic behavioral expectation for an active dealing with the challenges brought by aging and illness. Also, the high quality of life in old age is in line with a high attitude towards the use of medical technology and – considering the opinions regarding its benefits – perceived usefulness.

As technology is integrated into most aspects of life and increasingly changes our ways of working, communicating, and performing our daily routine activities (Boot et al., 2018), individuals come more into contact and interact with it in different contexts. Technology is also increasingly being used within healthcare, giving especially to seniors broad possibilities for (more) independent structure and organization of their day-to-day health management, well-being, safety and security, as well as their social interaction.

Health-supporting technologies, such as medical assistance at home and health care monitoring, have a great potential to help to meet the challenges of aging in place. However, attitudes towards technology significantly contribute to technology acceptance and

are important predictors of technology adoption (Lee et al., 2018). According to this study's results, the attitude towards use of medical technologies is generally positive: The reached average values prove that the participants find health-supporting technology useful and are mostly willing to use it. Unexpectedly, our findings indicate that the younger part of the population is slightly less enthusiastic about its deployment and wide-ranging potential. One possible explanation for this situation is that most of the young people do not depend on medical assistance, and/or do not know anybody who does, and simply cannot yet imagine the real need and the support it can bring. Still, the prevalent attitude suggests that – at least in Germany – people are positive about the technology and will use it corresponding to their demands. This assumption is also confirmed by the not existent effect of health status on the attitude towards medical technology, since the relatively positive mindset in this regard is apparent even without a concrete 'reason' which could be an existing illness.

Moreover, reasons *for* the use of medical assistive technology are obvious and there is a high consensus about it in the population. In our study, this argument is substantiated for the most part by the absence of differences between the examined user profiles. Although there are small differences regarding perceptions of the reliability of the measurement and added level of security, when using medical technology between young age group and seniors, and also between healthy and chronically ill individuals, the participants agreed about the majority of the perceived benefits. In contrast, regarding challenges and reasons *against* the deployment of digital assistance in home environments the opinions are significantly divided: The respondents of the senior group in our study simply disagreed with most of the named disadvantages, showing a high willingness to make use of the potential brought by this technology. On the contrary, young adults reach on average the highest values with respect to the perceived challenges in almost all cases; the means of the participants of the middle-aged group lie in-between.

These results are not consistent with current studies on general technology and computer use (e.g., Mitzner et al., 2018; Lee et al., 2018), where attitudinal barriers that affect technology uptake among older adults are still higher than among young adults, and the perceptions of self-efficacy and behavioral intention still point to a generally lower willingness to use computer-based technologies among older potential users. This discrepancy leads to the conclusion that either adoption of medical technologies is subject to its own dynamics of acceptance or it testifies that the

adoption behavior of such health-supporting technology in the *today's seniors* have changed, alongside changes in fields of nutrition, movement, and mobility when getting older. Additionally, it cannot be ruled out that research on long-term adoption of medical technology among seniors needs such extended acceptance models, as the ones used in the research of Chen and Chan (2014), who assessed digital products and services that could enhance independent living and social participation for older adults. For this, further examination and validation studies are necessary.

### 5.3 Limitations and Future Research

Although the study provided detailed and relevant insights, it is important to note some limitations, which should be considered for future work.

Indeed, the presented study is based on a representative sample and, therefore, forms a very good basis for generic statements. However, we only included opinions of adults from the German population, which limits the validity of the conclusions for the international forum. In addition, the examined user factors were limited to age and chronic illness, but acceptance, and thus successful adoption of medical technologies, is most likely influenced by other user characteristics, like for example gender, previous experience with computer-aided technology, and even income or financial situation of potential users. Further, considering the possible change in the perceptions of their own contribution to the process of aging, it would be also of interest to examine whether there are significant differences between younger (60-80 years) and older seniors (80 years and older) in their perceptions of the focal points covered here. Hence, future studies will need to address these limitations.

Another issue regards the methodological approach: In the current study we examined participants' attitudes towards medical technology on the basis of only three self-developed statements. In future studies, it would be desirable to review this setting more closely and supplement existing survey instruments. Finally, the study depicts only the current state, but systematic long-term studies are necessary to confirm true changes in perceptions, acceptance, and therefore, adoption of health-supporting technologies among persons concerned.

## 6 CONCLUSIONS

Medical technology affords a great potential in the graying societies of today. Health-supporting appli-

cations bring many benefits for older adults and persons with chronic illnesses, providing the possibility of (more) independent and active aging in place. This article provides insights into currently prevalent perceptions of aging in the German population, showing significant associations between positive attitudes in this regard and the perceived benefits brought by the use of medical technologies in home environments that may affect technology uptake among older and frail adults. The findings allow a deeper understanding of changing patterns regarding aging and the acceptance of health-supporting technology in modern societies, and show the impact of users' individual profiles on their autonomous shaping of everyday life.

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