Age reporting by and for older people in Uganda: relationships with frailty, human capital and population registration

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Abstract:
This paper investigates the accuracy of age reporting among people age 60 and older in a peri-urban area of central Uganda and the influences on the ages reported by those people and their carers. We find a high level of age-heaping on terminal digits 0 and 5, indicating poor knowledge of age. Contrary to other studies, we find that literate people were more likely to exhibit age-heaping and we link this to the absence of birth registration for this cohort and the introduction of National ID cards five years before our survey. We conclude that age-heaping is better interpreted as an indicator of registration machinery than of human capital. We also find that the health, functional capabilities, and education of an older person influenced the age ascribed to them by their carer. Carers who knew the older person less well were more likely to over-estimate their age, and the carers of healthy and more educated people were likely to report a younger age than that reported by the older person. Where people don't know their age, the age they report may also be influenced by their health and capabilities, making it difficult to establish true relationships between chronological age and outcomes such as health. In many disciplines self-reported age or age as reported by proxy respondents is accepted uncritically by researchers, but our study shows that in peri-urban Uganda age reporting remains approximate and biased, with strong implications for appropriate targeting and monitoring of interventions to support healthy ageing in such contexts.

Key words/short phrases:

Age reporting; Age-heaping; Human Capital; Frailty; Peri-Urban Uganda; Population Registration

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Introduction

Research on ageing is fundamentally dependent on the knowledge and reporting of age and older people are often defined as those over a particular age. Studies which seek to identify the way that experiences differ as people grow older - including medical and social gerontological studies of frailty, mortality, social needs and relationships – also depend on chronological age. Even research on more subjective and personal experiences of the ageing process, such as contrasting people's subjective or felt age with their chronological age, needs a reliable assessment of chronological age as a point of comparison. Such studies rely on the age reported by or for respondents, and rarely assess whether those ages are accurate. In many circumstances it is reasonable to assume that they are: in high income countries people need to report their age regularly; they possess documents which record their date of birth, which they are able to interpret because of high levels of literacy and numeracy. In such settings people may need to repeat their age so often they do not need a document or to do a calculation. Where people do not need to report their age frequently, where they do not have an accurate record of their date of birth, or where literacy or numeracy is poor, people's grasp of their age may be weaker, manifesting in age misreporting. Random errors in reported ages tend to cancel out, but systematic errors are common in certain circumstances and can seriously bias results. Age reporting is particularly problematic among older people in Africa (Aboderin, 2010), where 'The data [on the age of older people] available are so problematic that any conclusions about age-related health and welfare and their evolution over time and space are potentially compromised' (Randall and Coast, 2016, pp.143–4). This paper examines age reporting by and for older people in Uganda and discusses influences on the way that age is reported in a peri-urban community.

The systematic misreporting of age takes two main forms: age-heaping and age-shifting (Johnson et al, 2022, pp.13–14). Age-heaping or digit preference is the tendency to report ages in round numbers, often numbers ending in zero or five. It is measured using a variety

of indexes, such as Whipple's Index, which quantify the degree of digit preference. Age-shifting is the systematic over- or under-exaggeration of age, and it is frequently concentrated in particular age-sex groups. For example, young women might over-state their age, but middle-aged women are more likely to under-state it. It may be linked to a desire to be on one side of a legal age barrier (such as over the minimum age for renting a property) or to avoid a lengthy section of a questionnaire (for example in the Demographic and Health Surveys (DHS) women under the age of 50 have many more questions to answer). Age-heaping is much easier to detect in data than age-shifting, and so analyses of the quality of age reporting tend to concentrate more on the former measure. In this paper we also focus on age-heaping, although mention is made of other aspects of age-misreporting, and age-shifting as reported by the proxy respondent (carer) is examined.

Age-heaping tends to increase with age, and there is some evidence that over a certain age, age exaggeration also increases with age (Coale and Kisker, 1986; Smit et al, 1997). Age misreporting may produce misleading mortality rates (Coale and Kisker, 1986; Coale and Li, 1991; Elo and Preston, 1994) and leads to distorted dependency ratios (the proportion of children and/or older people in a population) (Randall and Coast, 2016) and population projections (what the population will look like in the future) (West et al, 2005). If reported ages reflect the health status of older people it becomes impossible to assess whether people are getting healthier as they get older, or whether additional years of life are spent in ill-health. Without reliable knowledge of chronological age, it becomes impossible to assess any discrepancy with subjective or felt age. Therefore, although individuals themselves may not place a high value on knowing their precise chronological age, accurate age reporting is still important for generating accurate demographic rates, for planning needs and services, and for understanding the ageing process and social gerontology.

This paper is derived from 'Pictures of Ageing in Uganda – A partnership to explore demographics, phenotype, and self-perception in a community of older people'. The project

brought together academics from medicine, psychology, psychiatry, demography, qualitative social science, and art. The team worked with peri-urban communities near Kampala, Uganda to co-develop an interdisciplinary pilot study in the area of health and ageing. Due to the importance of accurate age reporting for understanding experiences of ageing, a strong focus was on the reporting of age itself and this paper reports the findings from this component of the research.

Literature Review

The literature on age-heaping is concentrated in two academic areas: demography and economic history. The former field focuses on age-heaping as a marker of the quality of demographic data, and the latter on age-heaping as an indicator of human capital. Despite this difference in focus, they use the same tools, share an interest in calculating age-heaping for different groups in society, and there is also some overlap in the places and times which have been studied. Generally age-heaping is more common among older people, the uneducated, rural dwellers, and women, and this is observed in both the economic history (A'Hearn et al, 2009; Crayen and Baten, 2010; Földvári et al, 2012; Tollnek and Baten, 2014) and demography literature (Fayehun et al, 2020). Some studies find married people, particularly married women, report ages more accurately, and attribute this to women pegging their age to that of their husbands (Földvári et al, 2012). However, Elo et al. (1996) found wives were more likely to report their husband's age at death accurately than vice versa, and Malik (2021) found that in India women reported ages more accurately than men. In some circumstances, religion has also been associated with differences in age-heaping, with Jews exhibiting lower age heaping than Catholics (Tollnek and Baten, 2014; Juif et al, 2020).

The correlation between age-heaping and education or literacy has often been interpreted as a causal link, with an implication that uneducated people are unable to keep track of, or calculate, their age. For example, with reference to recent censuses in a variety of African

countries, Mba (2014) wrote that a 'high rate of illiteracy, especially among elderly people [sic], … is responsible for their inability to keep accurate records of their dates of birth' (see also Francis et al., 2019; Lyons-Amos & Stones, 2017; Shipanga & Shinyemba, 2023). In the economic history literature this relationship has led to the use of age-heaping as one of the most frequently used measures of numeracy and therefore of human capital (A'Hearn et al, 2009; Crayen and Baten, 2010). Many economic historians have taken a literal interpretation of this connection and seen age-heaping as a direct indicator of mathematical skills or cognitive ability (Tollnek and Baten, 2017; Perrin, 2020). However others argue it is also a function of census-taking practices (Elo and Preston, 1994; Elo et al, 1996; Spennemann, 2017), for example Soltyzek et al. (2018) argued that more careful questions about age and better training of enumerators improved the quality of age reporting. In general the reporting of age is better when information is gathered on date of birth rather than age last birthday (West et al., 2005), but this can also lead to heaping on digits other than zero or five due to preferences for rounded years of birth.[1] The presence of other forms of registration and record keeping can also improve age reporting in censuses and surveys; for example Rosenzweig (2021) showed that people with birth certificates were less likely to report heaped ages. Increasingly scholars are recognising that literacy and age-reporting are highly correlated because they have common roots in a process of administrative and cultural modernisation (Spennemann, 2017; A'Hearn et al, 2022b). Where people do not need to continually rehearse their age for administrative, legal, or social reasons; where they do not have documentation proving their age or date of birth; and where there is little cultural importance placed on knowledge of age or birthdays, age-heaping is likely to be more common. Age-heaping may therefore be a consequence of lack of knowledge of age, but the presence or absence of registration and the ways that censuses and surveys are carried out (including proxy reporting) are also likely to be influential.

Proxy reporting (people reporting on behalf of others - for example in many household census or surveys, and always in the case of death) is likely to be less reliable than an

individual reporting their own age. West et al (2005) found that in the 2000 United States Census, age information obtained from non-household members was significantly more prone to age-heaping than information from family members. Elo et al. (1996) found that spouses more accurately reported age at death than other informants and that wives were more accurate than husbands. Lankoandé et al. (2022) found that in Burkina Faso the quality of age at death reporting was much worse than the quality of age reporting for living people, and the same pattern was found for the United States (Elo et al, 1996; Preston et al, 1996). Studies of age perception based on facial photography indicate that it is more difficult to estimate the age of older people than younger, and that people also tend to be better at estimating the ages of people in their own age group (Voelkle et al, 2012). This is important because in most data collection methods (census and surveys) data for the whole household may be provided by a single respondent. Other studies observe that many assessments of age are informed, or even decided, by the interviewer (Pardeshi, 2010; Randall and Coast, 2016).

Estimated ages are likely to be influenced by cultural understandings of ageing - who is considered to be ‘old’ and the factors this depends on, which include health, social role and status (Hausknecht et al, 2020). Individuals who appear to conform to these markers of old age may be more likely to be assigned an older age by a proxy respondent. For example, ethnographic studies such as Glascock and Feinman (1980, quoted in (Kowal and Dowd, 2001)) suggest that capabilities (invalid status, senility, or physical characteristics) can affect others’ perceptions of whether a person is old, and that social role (such as work patterns, the adult status of children, or menopause) may also be influential. In many African societies status confers seniority and thus higher status individuals may also be assigned a higher age (Sagner et al, 2002). In most societies frailty and declining physical functionality are seen as markers of old age, therefore we expect older people who appear more frail and with more limited functionality to be considered older. This might also feed into people’s perception of their own age. Studies of age-identity (subjective, perceived, or felt age) in the

fields of psychological ageing and social gerontology find that it is common to feel younger than one's chronological age (particularly among older people), but that the experience of illness makes people feel older (Morelock et al, 2017; Bordone et al, 2020; Pinquart and Wahl, 2021; Demir Erbil and Hazer, 2022). Biomedical studies find that perceived age is generally a good indicator of biological age (the condition of the cardiovascular, metabolic, or immune system) which may differ from chronological age (Christensen et al, 2009; Jones et al, 2019) and this may be because perceived age is heavily dependent on health, capabilities and even expression. Voelkle et al. (2012) found that the age of happy faces tends to be under-estimated.

Age reporting in Africa/Uganda

Age reporting in Africa is generally acknowledged to be poor quality. Some overview studies on human capital have included African data: for example Crayen and Baten (2010) found high levels of age-heaping for those born in the 1940s and even higher levels for those born 50 years earlier, but it is unclear what countries contributed to which years. Research specifically on Africa finds decreases in age-heaping over the long term (1730s-1960s) (Cappelli and Baten, 2021), but continued high levels and little consistency in recent trends. Mba found that age reporting in African censuses has generally improved over time, but that there are still high levels of inaccuracy across the region, with better reporting in Southern Africa than West Africa, and East African countries in the middle (Mba, 2014). In contrast, evidence from the Demographic and Health Surveys (DHS) indicates little change over recent decades (Lyons-Amos and Stones, 2017). Fayehun et al. (2020) found that, in the Nigerian DHS, age-heaping was more prominent among men, uneducated people, and rural dwellers. Capelli and Baten (2021) found that former British colonies had lower levels of age heaping, which they attributed to differences in colonial education systems. Economic historians keen to substantiate a link between mathematical ability and age heaping in present day Africa have found that age heaping was greater among the parents of children who performed less well in mathematics tests (Baten et al, 2022). However, the evidence

presented by other studies is mixed. For example Francis et al. (2019) found that insured patients in Ghana exhibited more age heaping than uninsured; they attributed this to greater levels of illiteracy among the insured, but did not explain why this might be so.

However, few studies have looked at age reporting by or for older people and consequently, relatively little is known about age reporting among older people in Africa. A project to establish 'a minimum data set on ageing and older persons in Sub-Saharan Africa' took place in the early 2000s (Ferreira & Kowal, 2013), but focussed on identifying the sort of data which would be necessary, without specifically discussing the quality of such data (Randall & Coast, 2016). Lankoandé et al. (2022) and Wak et al. (2017) compared age reporting in censuses and well-established demographic surveillance sites (DSS) in Burkina Faso and Ghana respectively.[2] They found considerably more age heaping in census than DSS data, particularly among older people, which they attributed to more date of birth documentation for younger people and greater rigour and consistency in the DSS data collection process. The most comprehensive analysis of age reporting by older people in Africa is provided by Randall and Coast (2016), who compared the quality of age reporting among older people in a variety of countries in censuses and the DHS. They report that while knowledge of age or date of birth in various African countries is improving among younger generations due to increased schooling and administrative demands for date of birth, there are still considerable problems of age reporting among older people and those who are unschooled. They argue that age reporting among older people is particularly inaccurate in Sub-Saharan Africa, because of widespread social irrelevance to knowing absolute age, although relative age is important.

In the African context, there are few studies comparing an older person's age with the age that other people consider them to be. However some researchers have compared older Africans' subjective and chronological age, for example in Senegal (Macia et al, 2012, 2019) and Burkina Faso (Schönstein et al, 2021). While this work confirms the finding, from the

wider literature, that people's age identity is linked to their health, it also finds considerably less discrepancy between individuals' 'felt age' and their chronological age than in higher income countries. For example in Burkina Faso, self-perceived age barely differed from chronological age and the authors suggested this might be because youthfulness has a lower value than in high-income contexts (Schönstein et al, 2021). Similarly, felt age and chronological age were identical for 76 per cent of the sample in Senegal, and the authors argued that it might be harder for Senegalese older adults to 'ignore their corporeality' than in higher income countries; we interpret this to mean that with a relative lack of products and services which can make life easier, older people in Senegal experience more age-related limitations to daily life (Macia et al, 2019, p.829). While these observations may well have merit, it is notable that these studies did not consider the accuracy of the older people's reports of their chronological age. A lack of knowledge of actual age or birth date might mean reports of chronological and 'felt' age were similar not because both reflected chronological age, but because both reflected 'felt age'.

The literature therefore suggests that age reporting by older people in a peri-urban African context is likely to be poor, and that this might be linked to low numeracy or mathematical ability or to lack of knowledge of their actual birth date due to relatively low administrative demands for birth date reporting. It also suggests that the age that people report, and that other people consider them to be, might depend on their health status, capabilities, or appearance. This paper examines these aspects of age reporting by older people and their carers in a peri-urban area of Uganda.

Data and Methods

The Pictures of Ageing project developed a pilot study of 150 people thought to be aged 60 and older from three villages in the Busukuma sub-county in Wakiso District, about 25 kilometres from Kampala. A list of older people in these villages was provided by village officials and these older people were visited by the project team.

The questionnaire was carefully constructed so that first the respondent's family member or companion was asked what age they thought the older person was. Next the older person themself was asked their age. Following that they were asked more detailed questions about their date of birth, whether they had any documentation showing their age or date of birth, an event history to determine which major events they remembered, and a series of socio-economic, demographic, household, and health-related questions.[3] This is a locality with a Christian tradition (although 17 per cent of our sample were not Christian), and those who reported they had been baptised in the vicinity were searched for in the baptism records of their church, in order to obtain a date of birth reported at baptism. Baptism often occurs in infancy or childhood so these dates of birth may be more accurate than those reported later in life (Helleringer et al, 2019).

We use a range of analyses to consider reporting of age in our study population: the analysis of age heaping; participants' precision and consistency of age and date reporting; and assessment of the discrepancy between the ages reported by participants and carers. These approaches are described below.

Analysis of age heaping

Analysis of age-heaping includes a range of indices which detect heaping on zero, five or other digits: for example, Bachi's Index, Myers' blended Index, UN Age-Sex Accuracy Index and Whipple's Index. The Myers Index can identify heaping on a variety of different terminal digits, as can some adaptations of Whipple's Index (Shryock and Siegel, 1976; Spoorenberg, 2007; A'Hearn et al, 2009). However, the most widely used, easy to compute and interpret is the original Whipple's Index, which is very suitable for places that follow the most common pattern of heaping on terminal zeros and fives. Both previous studies and our data confirm this pattern for Uganda (Mba, 2014).

Whipple's Index is calculated by summing the number of persons aged 23−62 years (inclusive) who report ages ending in zero or five, dividing that sum by the total population

aged 23−62 years old, and multiplying by five to produce an index which is related to the quality of the age data. The Index can range between 100 (no evidence for age preference) and 500 (everyone reports their age as ending in either zero or five). Indices up to and including 105 are interpreted to mean highly accurate data, results between 105 and 109 indicate fairly accurate data, a range of 110 to 124 is approximate, 125 to 174 is rough, and 175 and over represents very rough data.

Whipple's Index is generally calculated for ages between 23 and 62, or sometimes 72. Older ages are omitted because the Index assumes rectangularity, i.e. that there is the same number of people in each single year age group across a ten year age range. This is not the case for older ages where high mortality rates mean older cohorts are smaller (Crayen and Baten, 2010), meaning that applying Whipple's Index to older ages over-estimates age-heaping. Nevertheless, Randall and Coast's modified Whipple's Index (Whipple60) for older people simply sums the people aged 60-94 whose ages ended in 0 or 5 and divides by the total number aged 60+. They used 94 as the upper limit because some of the sources reported ages over this in one single 95+ age group and they find good agreement between the Whipple and Whipple60 indices. As indicated above, the Whipple60 Index will produce inflated estimates of age-heaping because of the non-rectangularity of older ages, and this is exacerbated when the starting age for the calculation is age 60 rather than age 58.

We use Randall and Coast's Whipple60 Index to allow comparison with their study, but to address the non-rectangularity issues, our statistical tests (chi-square) examine whether the number of ages ending in zero or five is different to the number expected according to a linear decline in 'true' cohort size with increasing age starting at age 60 and declining to zero people at age 100. Under this scenario, we would expect 22.1 per cent of the population to 'truly' have a terminal digit of zero or five, and 12.3 per cent to have a terminal digit of zero.

We report Whipple60 Indices by gender, marital status, ability to read and write, frailty, and so on, and perform a logistic regression on the likelihood of reporting an age ending in zero or five to identify the most important correlates of age heaping.

Participants' precision and consistency of age and date reporting

We gathered various information about age: all respondents gave their age last birthday and their date of birth.[4] People who had been baptised reported their date of baptism and whether they had a baptism certificate. If a participant offered a day, a month and year for these dates, these were recorded. Where a day or month was not offered, these were recorded as one, so if an older person only offered a year of birth their birth date was recorded as first of January of that year. If they said that they were born in August, their birth date was recorded as first August. We classified these reported dates into three levels of precision: high precision (day not = one), medium precision (day = one, month not = one), and low precision (day = one, month = one).

We also considered whether reported age in years matched age as calculated by taking the difference between the reported date of birth and the interview date. We allowed two different ways of returning a 'consistent' age: 1) if a respondent reported their age last birthday; 2) if reported age was the same as the difference between the year of birth and the year of interview. For respondents whose birthday came before the date of interview (including all those with 'low precision') these two calculations were the same.

Discrepancy between ages reported by participants and carers

In order to investigate whether the age that other people assigned to an older person was affected by the frailty or functional capacity of the older person, or by the relationship of the observer to the older person, we analysed the difference between the age reported by the older person's companion and self-reported age. After a descriptive analysis, we performed two logistic regressions analysing a) the likelihood that the carer reported an age at least five

years younger than self-reported age, and b) the likelihood that the carer reported an age at least five years greater than self-reported age.

Results

Patterns of age-heaping

Figure 1 shows the distribution of ages returned by the respondents and their carers. Despite the low number of cases, there is strong age-heaping on ages ending in zero among reports from both respondents and particularly carers. There is also some, but less, evidence of heaping on ages ending in five.

Figure 1 about here

Table 1 shows the Whipple60 index and whether it is significantly different to that expected if there were no age-heaping. The higher the index, the less accurate the reporting of age. There is only one value (low precision date of birth) which does not indicate rough or very rough data, and this value still indicates approximate data.

The Index for all respondents is 167, and the number returning their age with a terminal digit of zero or five is significantly different from the expected number (22 per cent). As indicated by the graph this age-heaping index is even higher for ages reported by carers. Not all values are statistically significant, probably due to small numbers, but there is remarkable consistency in the table.

Table 1 about here

As expected, women exhibit more age-heaping than men. Other variables, however, do not show expected patterns. Contrary to other studies, married people exhibit more heaping than other groups, and all the indicators which might be interpreted by economic historians as representations of social capital show unexpected results: those who can read, write, have more education, and report date of birth with a day and month as well as a year are all

more likely to report an age ending in zero or five. This provides little support that age-heaping can be interpreted as an indicator of numeracy or cognitive development, or indeed human capital of any sort. Occupation and religion (not shown) do not show consistent patterns.

Many of the factors investigated above are likely to be highly correlated. To ascertain which were the most important determinants of age-heaping, a multivariate logistic regression of those reporting an age ending on zero or five was performed (Table 2; see also Supplementary Materials for descriptive statistics).

Table 2 about here

Very few variables were statistically related with age-heaping in the crude models, although the magnitude of the results matched the results of the Whipple60 analysis. Only those who rated their overall health in the last 30 days as good or moderate, as opposed to bad or very bad, exhibited significantly more age-heaping. Those who rated their health as 'very good' showed no differences in age-heaping compared to those who rated their health as 'bad and very bad'.

However, in the full model, after controlling for gender, education, place of residence, occupation, and ability to read, respondents who could write were nearly five times *(AOR:4.5; p=0.03)* more likely to report an age ending zero or five compared to those who could not. Once the ability to write was controlled the magnitude of the effects of education and ability to read reduced, probably due to the high correlation between these variables.

Participants' consistency in age and date reporting

To further examine older people's knowledge of their age and the relationship with literacy, we considered whether the age in years reported by respondents matched their age calculated by taking the difference between their reported date of birth and the date of the interview. Arguably reporting an age which is consistent with the reported date of birth is a

better measure of mathematical ability or numeracy than reporting an age ending in zero or five, and Table 3 demonstrates that contrary to age heaping, this measure shows an expected relationship with an ability to read and to write, and with educational level. However, there is very little relationship with the reporting of an age ending in zero or five. It seems that among older people in Uganda, numeracy or human capital is not well represented by age heaping.

Table 3 about here

Table 3 also shows that people who reported their date of birth with high precision were more likely to report a consistent age. This, together with the finding (shown graphically in Figure 2) that those who were able to read were considerably more likely to report their date of birth with precision, represents a conundrum. As might be expected, more educated and literate people were more numerate and more likely to give a precise date of birth, but they were also more likely to report an age ending in zero or five. The implication of this is the unlikely scenario that each five or ten years there was a cohort born who achieved higher literacy.

Figure 2 about here

The ways in which people might learn or rehearse their birth dates offer a potential reason for this unexpected finding. We asked respondents about date of birth documentation, and many people reported that they had a baptism certificate or national identity card. For those baptised as infants, a baptism certificate might give an accurate date of birth.[5] The majority of participants (129) were baptised and 116 gave a date for their baptism. Of these dates, 38 indicated a baptism during infancy, and of these infant baptisms, 16 reported having a baptism certificate. It therefore seems unlikely that many of the individuals in this study had documentation from the time of their birth with which to validate a birth date. Nevertheless, there remains potential for use of baptism records to validate age reporting for older people

baptized in infancy as long as careful consideration is given to study site selection (HelpAge International, 2011).[6]

At first sight, National ID certificates also appear unhelpful as the ID system was only introduced in 2014 (Resilient Africa Network, 2019) – five years before the year of the survey. If people had no documentation with date of birth at the time of registration for the National ID card, their identity could be verified by the Parish Citizenship Verification Committee.[7] In such cases a date of birth to go on the card would have to be chosen or assigned, and it is possible that dates of birth which yielded a round age in 2014 were more likely to have been given: such dates of birth will also have been round ages in 2019.

One hundred and eighteen of the 150 respondents had an ID card, and although those who could write were no more likely to have one than those who could not (78 per cent vs 81 per cent), 49 per cent of those with ID cards reported their birth date with high precision as opposed to 17 per cent without, and 14 per cent of those with an ID card reported an age which was inconsistent with their DOB compared to 23 per cent of those without. It is therefore possible that provision of ID cards 'fixed' a DOB for many people who previously did not know theirs and in doing so it 'baked in' a certain degree of age heaping. This might explain the finding that more literate people in this survey are more likely to report a rounded age through one of two mechanisms: firstly more educated people were quicker to sign up for ID cards (Resilient Africa Network, 2019, p.21; van der Straaten, 2022), and will therefore have been more likely than those with less education to have received one in 2014; secondly more literate people may be more likely to consult or refer to their ID card and therefore to have learnt their assigned birth date.

Discrepancies in age between respondent and carer

Next we consider discrepancies in the reporting of age between older people and their carers. The Whipple60 Index for ages of older people reported by carers in Table 1 indicated that proxy reports are less precise than ages reported by the respondents themselves. This

is expected, but it remains interesting to investigate whether there are systematic patterns in this imprecision, and in the direction of discrepancies in the reports by respondents and carers. In other words, are carers likely to report an older age than the older person themself reports, or a younger age? If there are systematic patterns, do these reflect characteristics of the proxy or of the older person?

It is important to remember that respondents may not know their age any more accurately than do carers, and that a finding that, for example, carers were more likely to give an older age could be due either to carers over-estimating the age or to older people under-estimating it.

Figure 3 shows discrepancies in age as reported by respondent and carer, by a variety of other variables. In these graphs, the dark shades on the left indicate the percentage of cases where the carer gave an age five+ years lower than the age that the respondent gave, and the slightly lighter shades on the left indicate one to four years younger. The lightest shade in the middle indicates that carer and respondent gave the same age for the respondent. The darker and darkest shades on the right indicate that the carer gave an age one to four or five+ years higher than that given by the respondent.

Figure 3 about here

For men there is little pattern - roughly the same proportion of carers reported a younger as an older age than the age reported by the respondent. However carers were more likely to give a lower age than that given by female respondents. It is possible that this could be due to carer type (men may be more likely to have had a spouse), or respondent characteristics (women are more likely to have been older).

The relationship and generation of proxy respondents (carers) affect how likely they are to give the same age response as the older person. Close relatives like spouses and children were more likely than other carers to report the same age as the respondent. They were also

slightly more likely to give a younger than an older age, which might be due to age-exaggeration by respondents. Grandchildren, however, were more likely to report an older age than the respondent. This might reflect a poorer ability of young people to gauge age and a tendency to think that older people must be very old, however other studies investigating perceived age suggest that age and gender of the person guessing the age do not usually affect the accuracy of the result (Jones et al, 2019). Neighbours and 'other' carers were as likely to report an older as a younger age, and 'other' carers (predominantly friends and maids), who probably knew the respondent least well, were least likely to report the same age that respondents reported themselves.

The health of a respondent can affect how old other people think they are. The carers of people in good health were more likely to offer a considerably (five+ years) younger age than the respondent. This held for various different measures of health which carers might notice, from self-rated health, to ability to carry out daily activities, to degree of physical activity. The carers of people in poor health were more likely to return an older age – particularly for the more 'objective' measures of ability to carry out day-to-day activities and degree of physical activity.

The relationship of carers and health of the respondent might be related: for example, older people were less likely to have a living spouse to look after them and may also have been in poorer physical health. Multivariate logistic regression was therefore performed to tease apart the effects of different influences.

Table 4 about here

Table 4 shows unadjusted and adjusted odds ratios (ORs) for the carer reporting an age five or more years lower, or, in a separate regression, five or more years higher than that reported by the respondent. The unadjusted results mirror those in the graphs above. Compared to spouses, all other carers were more likely to report a much older age than the

older person, and this was particularly likely where the carer was not a relative or neighbour. Those older people who were more physically active were unlikely to be allocated older ages by their carers (difficulty carrying out day-to-day activities gave a similar result but was not included in the adjusted model due to collinearity). Interestingly, the relatives or carers of people who could write were considerably less likely to suggest an age much higher than the age provided by the older person themselves (again, a similar result was obtained for ability to read but this was omitted from the adjusted model due to collinearity) and much more likely to be give an age at least five years lower. It is possible that those who can read and write appear more mentally agile to others than those who cannot.

Steffener et al. (2016) have shown that education and physical activity are linked to lower brain age, and Kwak et al. (2018) have demonstrated that brain age and subjective age are linked. We have already shown that the older people in our sample do not necessarily possess a firm knowledge of their precise date of birth and therefore of their exact chronological age, and it is possible that their own reported ages are influenced by their health and mental capacity. The results in this section demonstrate that even if this is happening, the physical capacity and literacy of an older person influence the age allocated them by their carer even more than they influence the age given by the older person themself.

Discussion

This paper set out to examine the accuracy of age reporting by and for older people in Uganda, and to assess influences on the ages reported. We have demonstrated that age-reporting among older people in Uganda is ‘rough’ or ‘very rough’, and therefore that little store should be put on the precise age that is reported by an individual.

Our analysis contributes to the debate about how to interpret the presence of age heaping. Our finding that literate people were more likely to report their age as a round number casts doubt on the common assumption that rough age reporting is due to the inability to keep

track of records and certificates or to calculate age from those documents (Mba, 2014; Lyons-Amos and Stones, 2017; Tollnek and Baten, 2017; Francis et al, 2019). Although more literate people were more likely to report an age heaped on 0 or 5, that age was more likely to be consistent with the date of birth that they returned than illiterate people, confirming that rough reporting does not indicate innumeracy or low human capital. We suggest that our finding is linked to the introduction of national ID cards five years before our survey took place, and the possibility that for many people such cards represented the first time they received a document with a date of birth, which was derived from a rounded age in 2014. Although we disagree that age heaping is an accurate indicator of numeracy, correlation between the two are common because the development of education and numeracy has often gone hand-in-hand with the introduction of registration and the growing requirement to report age or date of birth. However for today's older generations in Uganda, and probably other societies too, we should be wary of interpreting age-heaping as an indicator of low social capital.

Our theory needs further testing with a larger sample and an investigation of the link between the date of receipt of ID cards and literacy. However it strongly indicates that age reporting is a better measure of administrative modernisation, as argued by A'Hearn et al. (2022a) and Spenneman (2017), than of human capital and that the registration of births and issuing of birth certificates is likely to be crucial. The introduction of identification later in people's lives can result in the assignation of inaccurate ages, which may be rounded when they are given. If large segments of the population receive identification at the same time, this can introduce patterns of age-heaping among those segments. The current push for much needed registration and identity documentation (Setel et al, 2007; Hunter, 2019) may not, therefore, be accompanied by immediate improvements in age reporting among the elderly.

Age-heaping is easy to detect in survey data, but without reliable evidence of date of birth, it is very difficult to detect the systematic under- or over-reporting of age. If people do not know their age, do not have a certificate to look it up, or cannot read that certificate, the age they report might depend on their health, daily capabilities, or social roles. In other words, it might be a better reflection of their felt, perceived or subjective age, or how they see their position in the world (Gilleard, 2022). Healthier people might underestimate their age and unhealthy people overestimate their age, and this bias would make it difficult to investigate the true links between chronological age and frailty. Although we are not able to prove that people's own reported age was influenced by their health and functional capabilities, we did find that these aspects affected the age that carers reported an older person. Carers who knew the older person less well were more likely to over-estimate their age, and controlling for this, discrepancies in reported age between respondent and carer were largely due to the perceptions of the proxy respondent: in other words the health, appearance, or capability (including educational level) of the older people affected how old their carers thought they were. We can draw three implications from this.

Firstly, it means that proxy reports of age informed by health or appearance are highly likely to be systematically biased. Of course it might be the case, as found by Smit et al. (1997), that certain forms of poor health (particularly in terms of cognitive function) also reduce the consistency of age recall in respondents themselves. This sort of effect, although it will increase variability of results, is unlikely to produce a strong and important bias. In contrast our finding of a correlation between physical health and the assessment of age by others has important repercussions regarding surveys where information for older people is frequently given by proxy informants (eg by head of household). These findings are particularly important for comparisons of healthy life expectancies and differences between groups within places, between different places, and over time as different cultures and norms as well as underlying health status may affect assessments of age.

Secondly, there are implications for the use of other age-detection methods such as computer aided age identification. A suite of emerging methods for validating and improving ages using computer vision (these methods use a data set of validated ages to train a computer programme to predict age) have had success in distinguishing women under 50 from those over 50 (Helleringer et al, 2019). However poor health, ever-smoking, and prolonged sun-exposure were associated with large errors, and these may be the same sort of errors which affect human estimation of age (Helleringer et al, 2019). This suggests that computer vision may still be some way off producing accurate reflections of age among older people.

Finally, our research raises questions about the definitions of age. Our findings indicate that these peri-urban societies in Uganda operate with a more social-role or capability-based definition of old age than one based on birth dates, and this is unsurprising given the lack of birth registration for this cohort. It is possible that this will change in younger generations as more schooling and more heavily documented lives repeatedly reinforce individuals' knowledge of their own age and provide them with the documentation to check and prove it. At the same time, our findings remind us that chronological age – although crucial from the perspective of population modelling and forecasting – is not always a good indicator of biological age, which may be more important (although difficult to measure) for defining vulnerability and related interventions (Jylhävä et al, 2017).

Our study has a few limitations. Primary among these is the very small sample size, which is due to the pilot nature of the study and limited funding, but the indicative responses still provide useful evidence, suggest that a larger study would be very fruitful, and can be used to inform the size of such a study. It is also important to consider the possibility of bias due to non-response and coverage. Non-response rates in the study were low, with only three individuals not interviewed because of frailty. Possibly more worrying, the study sample was based on self-reports of age – we only interviewed people who claimed to be 60 years or

above, and therefore some of those who under-estimated their real age will have been excluded. Some analyses have argued that 50 is a more appropriate cut-off for old-age in Africa, where life expectancy is still relatively low (Velkoff and Kowal, 2007; Ferreira and Kowal, 2013), but we decided to only include people reporting their age to be 60 and over in this study as our sample size was small: if we had included those reporting ages of 50 to 59 the number of respondents in our study with higher ages would have been severely limited. A large study in the future, however, would benefit from including a larger age range. Because our focus was on the accuracy of the reporting of chronological age, we did not ask how old people felt they were, but it would be interesting to include this in a future study. Although our study highlighted some of the possible implications of a lack of identity documentation and inaccurate information on documents it did not address these issues in detail. This would be a fruitful avenue for future research using both qualitative data to gather perspectives from older people themselves as well as quantitative data.

Conclusions

It is difficult, if not impossible, to conduct research on ageing without relying on reported age – if only to identify older people. The accuracy of reported age is rarely questioned, but we have demonstrated that when many older people in Uganda report their age, they may be reporting something closer to their 'felt age', rather than their chronological age. And when others report the age of older people they are liable to use their appearance or functional capability as a guide, leading to systematic biases in proxy reporting. Felt or perceived age may be equally valuable to chronological age, particularly when planning services, but it should not automatically be assumed that reported ages accurately reflect chronological ages. To report their chronological age correctly a person needs: 1) to have an accurate record of their birthdate, 2) to be able to read that record, and 3) to be able to calculate their age from their birth date and the current date. The presence of age misreporting has generally been interpreted as indicating deficiencies in 2 (literacy) or 3 (numeracy), but in our

sample, age heaping had little relationship with the ability to calculate age from birth date and current date, and was associated with higher literacy rather than lower. We argue that the possession of a document made at or near the date of birth (such as birth or baptism registration), which shows that date, is likely to be a prerequisite for accurate knowledge of age. Literate and numerate people may rely on these, or documents gained later in their life which record a date of birth, for knowledge of their age. However the dates of birth on documents gained later may reflect an estimated age, and where many people gain such documents at the same time – such as during the widespread introduction of national registration – heaping on particular years of birth may be introduced into the population. In relation to places where relatively few people have birth certificates, therefore, both studies of older people and those developing health and social policies should be aware of potential age misreporting due to either hazy knowledge of a respondent's own age or proxy reporting by others, and the biases that these entail.

Globally, around 850 million people – around one in every nine – do not have an official proof of identity, which often prevents them from accessing services and fulfilling rights (World Bank, 2021). Nearly all of these live in LICs and LMICs and over half are in Sub-Saharan Africa. Lack of documents such as birth certificates remains a barrier to gaining ID (ibid), but despite a push for improving documentation and birth registration, a recent survey estimated that globally around 30 per cent of infants had not been registered, and 40 per cent did not possess a birth certificate (UNICEF, 2019). Together with our findings, these facts imply that many children born today may not have a firm grasp of their age when they reach older ages. Where birth registration is introduced it is likely to be accessed first by wealthier sections of populations, generating potential differentials in future age reporting. In these circumstances, the ability to gain an identity document in later life should not depend on the production of a birth certificate, even though that may result in the assignation of an inaccurate birth date.

Ethical Approval

Ethical approval was granted by Makerere School of Medicine Research Ethics Committee School protocol (SOMREC 2018-098), by Uganda National Council of Science and Technology (UNCST: SS246ES), and by Cambridge University.

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Declaration of contribution of authors

AR was involved in study design, acquisition of funding, undertook data analysis and wrote the manuscript; AK was involved in study design, data analysis, and revised the manuscript; SOW was involved in study design and revised the manuscript; JB was involved in data collection and revised the manuscript; SW was involved in study design and revised the manuscript. All authors approved the version to be published.

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[1] For example in the Namibian censuses of 1991, 2001 and 2011, there was heaping on ages ending in one (Shipanga & Shinyemba, 2023), and the Malawi censuses of 1998 and 2008 were characterised by heaping on ages ending in eight (Fajardo-González et al., 2014).

[2] Unlike wealthier countries, Africa has few surveys directed at older people, and most demographic data comes from censuses, nationally representative surveys such as DHS, and a small number of location-specific Demographic Surveillance Systems (DSS).

[3] Following the questionnaire some participants were invited to focus groups to discuss what it meant to be old, a team of artists created art works based on the older people, and a combination of artists and local NGOs led co-production art workshops with the older people themselves. These aspects were analysed and reported on by other teams within the project, as were detailed analyses of the health of the older people.

[4] All but three participants reported a plausible birth date.

[5] Although we searched in parish registers for the baptism records of the respondents, poor survival of records, lack of access, and migration meant that we were only able to identify nine baptism records this way.

[6] Ideally such a study would be undertaken in a region with a majority of Christians, relatively low migration, and a single, long-established parish with a tradition of birth (as well as baptism) date recording (Helleringer et al., 2019).

[7] www.ugandandiasporanews.com/2014/07/17/facts-about-the-uganda-national-id-project/

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Figure 1: Distribution of ages reported by older persons and by their carers

Table 1: Whipple60 Indices of age heaping

	Whipple60	Significance (p-value)	Number
All respondents	**167**	**0.00**	150
Respondents reported by carers	**253**	**0.00**	150
Sex			
Men	140	0.35	43
Women	**177**	**0.00**	107
Precision of date of birth			
High	**202**	**0.00**	62
Medium	**156**	**0.08**	24
Low	119	0.85	21
Reading ability			
Can read	**177**	**0.00**	96
Cannot read	148	0.18	54
Writing ability			
Can write	**189**	**0.00**	98
Cannot write	125	0.61	52
Education			
None or incomplete primary	**158**	**0.02**	98
Primary or incomplete secondary	159	0.14	41
Secondary or higher	**273**	**0.01**	11
Marital status (NB only one never married)			
Married/Cohabiting	**183**	**0.01**	52
Widowed	147	0.18	58
Divorced/Separated	**167**	**0.09**	39
Highest occupation			
Shopkeeper and higher	167	0.18	24
Skilled/semi-skilled labourer	**200**	**0.03**	25
Unskilled labourer	125	0.71	28
Agricultural worker	**174**	**0.04**	43
Missing	167	0.14	30

Notes: *A Whipple60 Index of 100 indicates that the expected number of people return an age ending 0 or 5. The higher the Whipple60 Index, the higher the likelihood of reporting an age ending in 0 or 5. The p-value indicates whether the number returning their age with a terminal digit of 0 or 5 is significantly different from the expected number (22%)*

Table 2: Logistic regression of age heaping (reporting an age ending 0 or 5)

Variable	Crude OR	95% confidence intervals	Adjusted OR	95% confidence intervals
Gender				
Male	1.0		1.0	
Female	1.4	0.66-3.09	1.8	0.79-4.09
Ability to write				
No	1.0		1.0	
Yes	1.8	0.86-3.85	**2.1***	**0.94-4.70**
Self-rated overall health status				
Bad & very bad	1.0		1.0	
Good & moderate	**2.7****	**1.20-5.89**	**2.6****	**1.18-5.90**
Very good	1.5	0.39-5.68	1.3	0.33-5.12
N			150	
Pseudo R^2			0.06	

Notes: *** p<0.01, ** p<0.05, * p<0.1 Results which are statistically significant at the 10% level are also shown in bold. OR = Odds Ratios. Crude ORs show results for the variable without other controls, adjusted ORs show results of the full model.

Table 3: Consistency between reported age and age calculated using date of birth

		Number	% Consistent	% Inconsistent
All		147	84.4	15.6
DOB precision	High	62	95.2	4.8
	Medium	21	85.7	14.3
	Low	64	73.4	26.6
Ability to write	Cannot write	52	75.0	25.0
	Can write	95	89.5	10.5
Ability to read	Cannot read	54	77.8	22.2
	Can read	93	88.2	11.8
Highest education level	None	98	78.6	21.4
	Primary	39	94.9	5.1
	Secondary	10	100.0	0.0
Age heaping	ends 0 or 5	50	82.0	18.0
	ends other digit	97	85.6	14.4

Figure 2: Precision of date of birth by ability to write

Figure 3: Discrepancies in age-reporting between older people and carer, by various indicators

Table 4: Multivariate logistic regression of carer reporting an age 5 or more years lower or higher than the age reported by the older people

Variable	Carer reports age 5+ years lower (pseudo-R^2 = 0.13)				Carer reports age 5+ years higher (pseudo-R^2 = 0.20)			
	Crude OR	**95% CIs**	**Adj. OR**	**95% CIs**	**Crude OR**	**95% CIs**	**Adj. OR**	**95% CIs**
Age of respondent	1.0	0.96-1.08	1.1	0.98-1.13	1.0	0.93-1.05	0.9	0.87-1.01
Gender								
Male	1.0		1.0		1.0		1.0	
Female	1.2	0.42-3.65	1.7	0.45-6.59	1.1	0.39-3.40	0.4	0.10-1.63
Ability to write								
No	1.0		1.0		1.0		1.0	
Yes	**5.6****	**1.25-25.29**	**8.1****	**1.60-41.58**	**0.2*****	**0.07-0.55**	**0.1*****	**0.04-0.48**
How physically active								
Not very/not at all	1.0		1.0		1.0		1.0	
Very and fairly	1.7	0.60-4.59	1.4	0.47-4.24	**0.3****	**0.12-0.91**	**0.3***	**0.13-1.07**
Relationship of carer to respondent								
Spouse	1.0		1.0		1.0		1.0	
Child/Grandchild	1.3	0.38-4.81	1.3	0.27-6.01	2.8	0.57-14.20	2.8	0.48-16.09
Other relative	0.5	0.05-4.97	0.5	0.05-5.20	2.3	0.30-17.89	2.9	0.31-26.37
Neighbour	1.4	0.22-8.25	1.0	0.14-7.58	2.8	0.36-22.32	5.3	0.55-51.42
Other	3.4	0.78-14.50	3.3	0.68-16.45	**7.1****	**1.23-41.25**	**12.2****	**1.73-85.89**

Notes: *All regressions included 150 participants. OR = Odds Ratios. CIs = Confidence Intervals. *** p<0.01, ** p<0.05, * p<0.1. Results which are statistically significant at the 10% level are also shown in bold.*

Supplementary Materials

Descriptive Statistics for Table 2 (Age-heaping logistic regression of participant's age ending 0 or 5)

Variable	Total (n=150)	Age ending 0 or 5 (n=50)	Age not ending 0 or 5 (n=100)
Gender			
Male	43(28.7)	12(24.0)	31(31.0)
Female	107(71.3)	38(76.0)	69(69.0)
Ability to write			
No	52(34.7)	13(26.0)	39(39.0)
Yes	98(65.3)	37(74.0)	61(61.0)
Self rated health			
Very good	14(9.3)	4(8.0)	10(10.0)
Good/Fair	84(56.0)	35(70.0)	49(49.0)
Bad/Very bad	52(34.7)	11(22.0)	41(41.0)

Descriptive statistics for Table 4 (care taker reporting age >=5 years higher and <=5 lower than respondent)

Variable	Total (n=150)	Carer reports age 5 or more years higher (n=19)	Carer reports age within 4 years of age reported by older person (n=111)	Carer reports age 5 or more years lower (n=20)
Gender				
Male	43(28.7)	5 (26.3)	33(29.7)	5(25.0)
Female	107(71.3)	14(73.7)	78(70.3)	15(75.0)
Ability to write				
No	52(34.7)	13(68.4)	37(33.3)	2(10.0)
Yes	98(65.3)	6(31.6)	74(66.7)	18(90.0)
Physically active				
Not at all	13(8.7)	1(5.3)	9(8.1)	3(15.0)
Not very	47(31.3)	11(57.9)	33(29.7)	3(15.0)
Fairly	71(47.3)	7(36.8)	54(48.6)	10(50.0)
Very	19(12.7)	0(0.0)	15(13.5)	4(20.0)
Relationship to care giver				
Spouse	39(26.0)	2(10.5)	33(29.7)	4(20.0)
Child/Grand-child	60(40.0)	8(39.6)	44(39.6)	8(40.0)
Other relative	18(12.0)	2(13.5)	15(13.5)	1(5.0)
Neighbour	15(10.0)	2(9.9)	11(9.9)	2(10.0)
Other	18(12.0)	5(7.2)	8(7.2)	5(25.0)