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From quantified to qualculated age: the health pragmatics of biological age measurement

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Abstract There is growing interest, within the social sciences, in understanding self-quantification and how it affects health practices in contemporary society. There is, however, less research on how ageing and health measurement relate, even though this relationship has become more pertinent with the growing availability of services and devices offering biological, personalised age measurements, from simple online questionnaires to telomere length quantification. Little is known about who uses these devices, why they use them and the socio-technical implications of such uses. To explore these issues, we conducted semi-structured interviews and focus groups with users of measurements of biological age (BA) in Denmark. We found that participants engage with the measurements with a degree of scepticism regarding their technical validity, reliability and sensitivity. Rather than seeking an exact biological quantification, participants use measurements as a pragmatic, rough indication of individual health. We develop a conceptual model to understand participants' engagement with BA measurements, which suggests that, instead of a substitution of chronological age for BA, users gauge the difference between the two to qualify their present and future individual trajectory in a lay model of the relationship between functional capacity and age.

Keywords: self-quantification, biological age, qualculation

Introduction

Increased use of technologies that monitor and assess personal activity and health metrics in the last decade has drawn attention from social scientists as this is seen to represent shifts in social and cultural health practices (de Laet 2017, Lupton 2013, Schüll 2016). Such interest in self-quantification practices as a particular form of health intervention – from scales and food intake registration to pedometers and blood pressure monitors – has not extended to the measurement of age (*pace* Marshall and Katz 2016), despite the fact that age information is routinely collected from individuals by public authorities – to implement age-stratified programmes such as pensions or health screening – and by life and health insurance companies for more than a century, and is habitually used in everyday interaction for the purposes of categorisation (Coupland *et al*. 1991). Focus on age is further justified by the contemporary

investment in establishing an alternative, more accurate, individualised index of ageing, hinged on the technological possibility of manipulating the rate of ageing to delay the onset of age-associated diseases (e.g. Partridge *et al*. 2018) and the establishment of 'active ageing' programmes to extend healthy life expectancy (Lara *et al*. 2015).

As part of this process, there has been, in the past two decades, a proliferation of products, platforms and services offering tests to ascertain individuals' biological, functional, 'body' or 'real age', from simple algorithm-based questionnaires – such as that provided by the Real Age® platform – to those using biomolecular techniques for telomere length measuring (e.g. https://lifelength.com). Although companies claim such services or products have widespread use – Real Age® state more than 43 million people have taken their test (https://www.sharecare.com/static/realage, accessed 15 October 2019) – there is no independent data about the magnitude of the use, or studies about who uses these devices or why they use them. Focusing on such uses, we suggest, provides a unique insight into how health technologies and data infrastructures shape and are shaped by social and cultural enactments of the life course (Joyce and Loe 2010, Joyce *et al*. 2017, Moreira 2017).

To explore these issues, we conducted semi-structured interviews (n = 13) and focus groups (n = 17) with users of alternative age measurements in Denmark. Differing from longevity-seekers' deployment of age calculation studied by Fishman *et al*. (2010), we found that participants engage with the measurements with a degree of scepticism regarding their technical validity, reliability and sensitivity. Rather than seeking an exact biological quantification, participants use measurements as a pragmatic, rough indication of individual health. We use these findings to develop a conceptual model where the measurements become part of a feedback loop between (i) the measurement itself, (ii) participants' embodied health practice and (iii) a specific imaginary of functional capacity through the life course. We propose that this particular form of reasoning should be understood as a form of everyday 'qualculation' (Cochoy 2008; see also Gard and Lupton 2016).

In the following section, we provide a brief critical review of research into 'quantified and digital health' and suggest the concept of qualculation as possible solution to the tensions that exist in that field. After describing and justifying our method, we detail empirically the different components of our conceptual model. We then show how these components together create a pragmatic stance towards the age measurements and their relations to health.

From quantified to qualculated age

Research into quantification of health has in the last decade been associated with work focused on the growth of digital apps focusing on health, and the exploration of the cultural meaning, social consequences and often also ethical implications of such devices. This has enabled a confluence between a variety of areas of work, where more established domains such as the social and cultural studies of health and medicine or science and technology studies (STS) have overlapped with newer fields such as critical data studies. Although the emergence of new digital platforms and applications, and associated algorithms, has facilitated and arguably accelerated the use of personal health measurement and data, these devices build upon specific metrics which have a longer history of analogical mensuration and registration (e.g. BMI, heart rate or scalar assessment of 'mood') or more recent deployment of medical technologies in domestic settings (e.g. Oudshoorn 2011). This dis/continuity is compounded by the point the entry social researchers have used to understand the consolidation of digital health mensuration practices. In our view, research on quantification and health is characterised by a tension between analyses that focus on how such devices partake on the transformation of social and political configurations, on the one hand, and work that is concerned with exploring technology-in-practice, on the other.

The former are characterised by a conceptualisation of health quantification as a Foucauldian 'dispositif' – an apparatus that articulate ways of knowing with forms of power. In this, the proposed robustness of the data recorded is linked to the enactment of moral obligations on the part of the users, supporting the maintenance of neoliberal 'calculative subjectivities', through better 'self-knowledge' (Lupton 2013) and the pursuit of optimal ageing (Katz and Marshall 2018). These digital health technologies differ from more established surveillance technologies in the way they link to a horizon of technological expectations. In this, the recording of information in the present distally engenders the promise of health in the future (Petersen 2018), bringing outside the clinic the forms of reasoning and re-imagination of the life course that Armstrong (1995) labelled surveillance medicine. Indeed, it can be suggested that one of the central promises of digital quantification and tracking is the extension of 'health span' over the life course. This is nowhere more visible than in biological age (BA) quantification practices, where 'the potential optimization of aging bodies and the promise of extended independence and agency into later life' is key (Katz and Marshall 2018:65).

The latter group of studies evidence how the uses of health quantification devices and apps are entrenched in a complex and ambiguous relation of knowledge, power and authority (Barta and Neff 2016, Nafus and Sherman 2014, Neff and Nafus 2016), that question the validity of measurements and the efficacy of data, as these are in tension with other forms of valuation and are embedded in situated, fully laden socio-material arrangements (Langstrup 2013, Pols *et al*. 2019). Aligned with STS work on users of technology (Oudshoorn and Pinch 2003), in this strand of research, the use of health tracking and quantifying technologies is explored as a process that is lived through, reflected upon and experimented within a situated and evolving relationship with other elements of people's lives. Thus, users 'in no way cede authority to the supposed objectivity of devices or the quantitative nature of sensor data' (Nafus and Sherman 2014: 1789; also Ruckenstein 2014). In this, practices are significantly underpinned by identity work and belonging, as well as particular technoscientific imaginaries. This means that metrics cannot be simply linked to discrete forms of action or 'health behaviours', but are complexly entangled with patterns of institutional life, cultural practices, innovation processes and the like.

We propose that one possible way to disentangle the tension between these two approaches to health and age quantification is through deploying the notion of qualculation. The concept of qualculation was proposed by Cochoy (2002) in the context of the conceptual transformation in economic sociology proposed by Michel Callon (1998). Taking as point of departure Callon's proposal that calculation is an action made possible by a careful arrangement of information, infrastructure and particular norms of practice, qualculation refers, thus, not to a failure of an individual or agency to calculate odds and outcomes, but by a different collective arrangement of devices and information. The concept of qualculation aims thus to understand situations where calculation is unachievable, encapsulating 'the very delicate evaluation of the best choice when calculation is not possible' (Cochoy 2008:26). As a specific type of situated judgement, qualculation is instead equipped by mundane, not fully formatted, objects and qualitative points of reference.

In our study, we found that the uncertainties, regarding the validity and reliability of the age measurements, led to users using the information provided by the health assessment into a form of qualculation. Their self-evaluation combined, as we will explain below, untrustworthy numerical information with embodied knowledge about their health practices and an established, but not fully articulated, model of the relationship between health and ageing. The relationship between these three components constitutes, we suggest, a pragmatics of health, that is, a qualculative practice, whereby measures of health transform and are transformed by everyday practice (Moreira 2018).

Design and methods

We used qualitative research methods to study the ways people use and make sense of BA measurements. Our aim was to purposively recruit users of alternative age measurement devices, aiming to obtain a sample of users of different types of techniques and instruments that we knew were available: questionnaires, biomolecular tests, composite measures, etc. Our first recruitment strategy entailed advertising the study in national newspapers and social media. This recruitment strategy was not as productive as desired; it was complemented, using fieldwork information, by advertising in gyms and, after initial recruitment, by snowball enrolment of further participants.

This resulted in a sample predominantly composed of bioimpedance test users (26/27). This is understandable as, in Denmark, these tests are often found in gyms or offered in occupational health assessments at work. These tests assess body composition (water, fat and muscle) by measuring the differential ability of biological tissues to impede electric current (Martinsen and Grimnes 2011). The use of body impedance analysis to determine BA hinges on population-based data which suggest an increase in fat-free mass to fat mass ratio (e.g. Kyle *et al*. 2001), and a decrease in muscle mass as individuals age. Commercially available bioimpedance tests use an algorithm to match an individual's body composition to that found on average on a particular age category in the population. We were also able to recruit five participants who had used an online 'real age' questionnaire, which gather anthropometric and health behaviour data. We were unable to recruit users of biological tests such as telomere length measurement. Of the 27 participants, 21 were female and six were male. Ranging from 21 to 75 years of age, their median age group was 60–69. Ten participants had college or university education, and 17 had a Masters education or above. Twelve participants took the measurement test once, nine took the measurement test twice and six had been measured three times or more. Seven had encountered the measure at a sports activity (gym or running), six at work, five at a health event, four in allied health (dietician or physiotherapist), three at a clinical trial and one online.

During 2017–2018, we conducted 13 semi-structured interviews and four focus groups with 17 participants. Three participants from the interviews were also part of the focus groups. Focus group 1 had seven participants, focus group 2 had four participants, focus group 3 had four participants and focus group 4 had five participants. Recordings were transcribed verbatim. We used the emerging analytical findings from the semi-structured interviews to structure and inform the focus groups. Analysis was guided by the use of constant comparison, thematic analysis and deviant case analysis. We used constant comparison and inductive coding (Strauss and Corbin 1998) to identify themes and forms of reasoning used by participants to make sense of their use of the biological ageing measurement devices. We used analytical induction (Katz 2001) to develop hypotheses about the necessary and/or sufficient conditions for the deployment of particular forms of reasoning. The analytical framework was developed and validated at three analytic workshops with all members of the study team, which was then systematically applied to the data. We further validated the framework through a deviant case analysis, focusing on the only participant who was unable find value in the use of the devices (Figure 1).

One possible limitation of our study is that the sample is constituted by a self-selecting group of highly educated individuals. Further, as a group, they cannot be seen to represent early or enthusiastic adopters of a 'new' technology. However, their cultural capital combined with the circumstances in which most of them encountered the technology, enabled participants to provide a rich, critical assessment of the value of the devices in their lives.

Figure 1 *Deviant case analysis: the frustrated systematic thinker*

The health pragmatics of BA measurements

Our analysis showed that users displayed complex reasoning about the meaning of the measurement and their bearing upon their on-going identities and practices. We found that this

reasoning was underpinned by a socio-material arrangement, which related (i) the materialised measurement to (ii) users ongoing embodied practices and to (iii) a lay model of the relationship between functional capacity and age. In the subsections below, we explore empirically the dimensions that characterise each one of the elements of this relationship.

The measurement

Participants generally viewed the measurement with scepticism. Their critical assessment of the metric relied on whether the results provided could be put into practice and be used to support their current or future tactics of fitness, diet, etc. It was therefore embedded in an appraisal of how modifiable their health state was, given their previous experience and their age.

Participants' critical reflections on the age measurement focused on its usability and actionability, but for it to be actionable, the measurement needed to be convincing. Crucial in this was their judgement on whether the difference between chronological age (CA) and BA was of a reasonable amount. In interviews, users made implicit references to this reasoning, taking the metric to be serious and trustworthy only if the difference was within a range of 5–10 years. To further probe this issue of deviation, in subsequent focus groups, we asked participants if the ideal measure was a BA of 0 years. We were well aware that the question was in some way absurd, but used it to probe into the logics that the participants used to make sense of the measure. One of the participants expressed how she would react to such an anomaly:

> In that case I would think that there's something totally and utterly wrong with this measurement technique and the entire philosophy behind it, and then I'd just reject it. Then it's totally meaningless [P3, focus group 2, p. 29].

In such a thought experiment, the measurement would violate the rules governing the interaction of users and instrument. This situation would prompt an examination of the 'measurement technique and [its] entire philosophy', supporting another form of engagement that was no longer practice-oriented ('I'd just reject it'). In this hypothetical situation, participants would be compelled to 'open the black box' of the measurement by examining its 'philosophy'. Indeed, in further discussions in focus groups, a variety of instances were narrated where those who had received measures differing considerably from their CA did question the scientific and technical underpinnings of the instrument. For example, P9 (participant 9) and P12 queried the possibility of constructing one valid body age:

> I have to say that my hands are my age [78]. But the rest of me (. . .) there I am ok. (P9, focus group 1, p. 8).

> I have a bad knee as well. And then I'm told that I'm super healthy, so it's a little hard for me to say (. . .) Because there are other parameters that you have to add than just muscle mass or something. (. . .) What's the purpose of showing one's age if there are other things that play in, that makes you feel older than 37, and it could be something with the skin or whatever (P12, focus group 2, p. 6).

The participants argued that the variation on the rate of ageing across the body undermined the ability to devise a single metric of biological ageing. Participants reasoned that the overall health of individuals is distinguished from its parts, often expressed in lay language as the difference between having the 'body of' a person of a specific age and with having the 'heart of' a person of a different age. This difference contrasted with the singular metric provided by the instruments used. As a result, the metric was rendered as an artificial or constructed measurement that bore little relationship with the body it was gauging.

Another problematic aspect of how the measurement was assembled was its relation to normative data. Some participants were aware that the BA assessments they used drew on population data. When presented with unexpected results, one of the explanations offered was that the database contained flawed information. For example, P8 wondered whether the data were up-to-date:

> Maybe it's also because when we grew up, right, then when you were 63, that was just old, right. And you're not anymore. Like my grandparents they just walked around and looked forward to retirement, and there is not really anyone the same age as me who is looking forward to it. (P8, focus group 3, p. 17).

In trying to account for a BA lower than expected, the participant offered the possibility that this was because it drew on old data. Again, this shows a complex understanding of the production of metrics. By relying on old data, the participant was arguing, the metric had not taken into account changes in life and health expectancy that have been observed in recent years. As a result, it was comparing the health of a person of the current generation with the average health of a previous, less healthy cohort. A related, data-centred critique, articulated by P22 (interview, p. 9) questioned the methodological basis for using population statistics that included groups with very poor health early in life in assessing the fitness of the healthy individuals present in the focus group. Was it comparing apples and pears? Perhaps, healthy individuals should be assessed in relation to persons in equivalent categories of life-course trajectory and age? At the basis of both these evaluations was the question of the reference population, both in relation in its technical sense and in supporting users' understanding of their position in the distribution of health in relation to the population.

The link between individual and population was also challenged in other ways. Participants often explained anomalous results by the fact that the assessment was based on data that missed key information about the process of individual ageing. One dimension of this related to how life circumstances became inscribed in the body. One of the study's participants expressed this by saying that in view of a discrepant metric, 'the cracks on my heel will prove [the measure] wrong' (P8, focus group 3, p. 31). This encapsulated a divergence between an understanding of ageing as an evolving combination of genetic and environmental elements and the more static population-based view of ageing enacted by the instruments. A second dimension of the critique referred to how this combination was dependent on an experiencing subject, or as another of the study's participants put it, on 'the total number of heart beats and what the eyes have seen' over the course of one's life (P21, interview, p. 13). As such, users attributed the failure of BA measurement to the use of a flawed epistemology and ontology of ageing that excluded the embodied individual from its assemblage.

Ultimately, many participants found that the BA measurement was suggesting a controllable relation between life and death, which they did not agree with. In the focus groups, the uncontrollable death event was illustrated by drawing on the same bus metaphor:

P7: Like, I'm thinking, even if you are being measured to be younger, then there is no guarantee that you will have that time longer to live in, compared to whether like, if you are 37 or 54, because there can come all kinds of different stuff in, right?

P8: A bus can come across (focus group 3, p. 8)

These flaws encouraged participants to seek for a wider explanation for the existence of the instrument. This resulted in linking the BA metrics to a transformation of organisational modes of governance:

> It is, if nothing else, the idolatry of numbers [dyrkelse af tal] because we are very focused on numbers. You know, key performance indicators boom boom boom, you know? A lot of

> stuff is expressed through numbers even though the underlying things aren't numbers or something that you can actually measure objectively. And therefore every time it's got something to do with numbers, it becomes something objective. That is how it is perceived. There is something final about it [slams into the table] because this has been measured and weighed. (P3, focus group 2, p. 11).

Here, 'performance indicators' alludes to the practice of using numerical information to monitor and evaluate the functioning of organisations or its members. In this, P3 was suggesting that the narrow character of the metric used was driven by this political need, so that measures are given to 'something that you [can't] actually measure objectively'. The replacement of the numerical for the objective has political consequences in that 'there is something final' about what 'has been measured and weighed', leading to a suspension of the critical capacity to question why and how something has been measured. For some participants, the measurements were performing a form of politics that was disempowering. This was particularly concerning because this 'tyranny of measurement' (P24, focus group 2, p. 64) was itself seen to be driven by profit-driven interests. Participants viewed the politics of measurement partially in contradiction with the values of the country they lived in – and its welfare tradition – doubting whether such metrics, unlike the State's programmes, would contribute to 'population wellbeing' (P3, focus group 2, p. 66).

The embodied practice

As was referred in the last section, the study's participants viewed the difference between BA and CA as malleable within a specific range, outside of which the measurement became defective. Their pragmatic engagement with the metrics asked whether the information it provided could be converted into actions and used to support their current or future tactics of fitness, diet, etc. As such, participants' efforts were focused on translating the metric into one specific domain or set of practices:

> You can do something about the results. Of course some of these tests are more elaborate than others, but changing your diet or your activity level, or getting more sleep or are you getting more stressed or should you try to reduce the amount of stress in your life. I mean you can always do something. (P24, focus group 2, p. 31)

Here, P24 articulates how actionability conferred value to the metric but there was uncertainty about which domain the metric should inform. While 'more elaborate' tests could give directive information on which domain to act, the BA metrics provided an opportunity to reflexively engage with possible courses of action. In a significant way, the metric enabled users to be in control of that process of translation. This, however, puts responsibility on the user to be in charge of the process and to be accountable for it:

> If you are good at directing your body in the right direction, then it will be younger [in BA] than it is purely physiologically, and if you are not good at taking care of your body, then it will be older. (P5, interview, p. 10).

The relative difference given in the measurement between CA and BA was the basis for a qualification of how 'good at taking care of your body' one is. This was not a purely factual matter but embedded in a complex form of moral judgement. The measurement enabled participants to attach qualities of mastery and control to their embodied practices, a low BA being associated with attaining "some kind of indication of success, that she is in really good shape" (P12, focus group 2, p. 22). In this, participants emphasised the ability of the measure to support tinkering with their already health-oriented embodied practice encased within a particular identity:

> Because if [the BA] gets older than you... Maybe you have an image of a person who might be a bit indifferent. That you don't reflect on how you look or that you [...] not really think about your actions. [The measure] just as much indicates that, if you get an older score. (P12, focus group 2, p. 13)

P12 provided the reasoning behind this coupling of health and identity. As he puts it, obtaining a relatively older BA prompts a self-image that is associated with a lack of care for 'how you look' and unwillingness to action a different embodied self. In short, it qualifies you as someone who is 'a bit indifferent'. From this perspective, the measurement acted as a 'portal' onto users embodied moral worth, telling a truth about their ability to maintain and transform their body that was not available only by fitness tracking, weight checking or any other health monitoring practice. This capacity of the test to reveal one's true identity manifests in P5's description of the emotional effect that the measurement had on her:

> I felt undressed, like he was looking right through me. [The researcher] was nice and kind, but he was there with an agenda. He was supposed to measure my body, he was supposed to read my body and know what was there on the inside. (P5, interview, p. 7)

The test had been conducted by a researcher in the context of a clinical trial, P7 viewing his 'agenda' as wanting to obtain an accurate recording of the measurement. As it turns out, in the occasion, she scored the same BA as her CA (23). She was left puzzled and embarrassed because, as she said, she had anticipated a better score, believing she lived a generally healthy life. The story was told as a critical moment where the participant was found to be in 'the wrong face' (Goffman 1967), the test having provided information that discredited the image she was publicly trying to put forth. The test, in this sense, enabled the researcher to look beyond her public face and to 'know what was there on the inside'.

That participants ascribed such power to the tests might appear paradoxical considering users' scepticism about the validity of the measurement. However, this is only if we assume that their aim was to quantify precisely their health status. If, on the contrary, we consider that users were mainly after an indication of individual effectiveness, then the measurement becomes part of a much more mundane reflexive negotiation of identity; one element in a permutating situated assemblage.

The negotiated aspect of users' interaction with the measurement was evident when focusing on whether participants would take the measurement again. The two typical responses we obtained to this question can be seen as different sides of the same coin. On the one hand, some said they would not because they valued the fact that they could not prepare and plan the timing of the first BA measurement they underwent. As P20 put it, knowing what she knows now about the test she feared that she would probably cheat by choosing the "right time, when I was in the best possible shape" (interview, p. 12). For those users, the instrument worked best as a blind test, reducing bias and influence from the user. On the other hand, there were those that exactly valued this capacity of the test to respond to the users' actions. For example P26, who worked out a lot, said he would use the measure to explore "how I could utilise my work out hours in the optimal way" (focus group 1, p. 36). In this approach, the measurement was used to test whether the small modifications he made to his training routine had the wished effect. When, how and for what purposes the measurement should be used were seen as questions that users could pragmatically address.

The role of the measurement in supporting users' negotiations of their embodied identity is powerfully encapsulated in P8's account. As a cancer survivor, who has had a double mastectomy and parts of her liver and gale bladder removed, as well as being a chronic pain patient

and survived a blood clot in the brain, she was positively surprised by her BA, when she compared it to her history. At the age of 61 she scored a BA of 72, and her goal then became to equal her BA and her CA at the next measurement. She considers herself older than her CA because she has gone through a lot of medical interventions. She has been measured to be between 48 and 72, and so she must be, in her own view, 72:

> I get relatively big amounts of exercise compared to people that are sedentary. Like, I try. But I have gotten very bad feet, so unfortunately I can't walk that much anymore, so I count myself more as a 72-year-old from those measurements. (P8, focus group 3, p.4)

In this case, the measure became motivational, as she used her BA to look for ways of adjusting her embodied practice in order to reach her goal, and consequently seized to eat candy. She was happy to score 48 in BA, but due to her medical history and problems exercising, the high measure of 72 reflects her self-image better.

In this section, we have explored how the users related the measurement to their embodied practice. We have demonstrated how the participants project moral standards into the measurements, as well as use the measure to confirm or adjust their embodied practice.

The imaginary of functionality in the life course

The qualifying relationship between embodied practices and the measurement was mediated by how users drew on a model of the relationship between age and ability to position their present and future selves. We label it a model for two reasons. First, because it worked as a heuristic device by simplifying the complexity of the ageing process. Second, because it shows remarkable similarities with the model the WHO has used since the turn of the century to support active ageing programmes (see Figure 2). The figure enacts a narrative about the temporal unfolding of life framed in terms of 'functional capacity', that is, a person's somatic ability to perform daily activities (WHO 1999).

We are not claiming that users were familiar with the WHO model itself, but instead that they articulated a cultural imaginary of the life course in which the model features. Showing the structured malleability of the ageing processes (Lassen and Moreira 2014), it is also aligned with more entrenched representations of the 'arch of life'. As one of the focus groups participants put it,

> Life goes like this, in a kind of curve [demonstrates with hand gesture], the way of life or what you could say, it goes like that forwards, where we first strengthen our, like we go from child to young and to grownup, right? And there comes a climax there, and then it starts like going the other way, right? (P18, focus group 3, p. 34).

Describing life as a 'curve', P18 then provides a narrative for its organisation in terms of 'strength', its gain, apex and loss. This process is underpinned by the recognisable succession of life course roles: childhood, adolescence, adulthood. After adulthood, there comes a period where 'it starts going the other way'. It should be noted that P18 did not refer to that period as 'old age'. This is because, contrary to the other 'phases' mentioned, the period of decline was not seen by the study's participants as necessarily entailing an embodied identity that they associated with old age. Participants spoke of the period of decline as a reduction of the capacity to control biological or physiological age.

In adulthood, the potential for modifying one's 'body age' is at the highest point:

> [The idea] that the closer you get to 30, then it just goes downhill, I mean [is] physiologically right, so you slow that development if you have a body age younger than yourself, you might say, if you are still in your 20s, right. (P5, interview, p. 15)

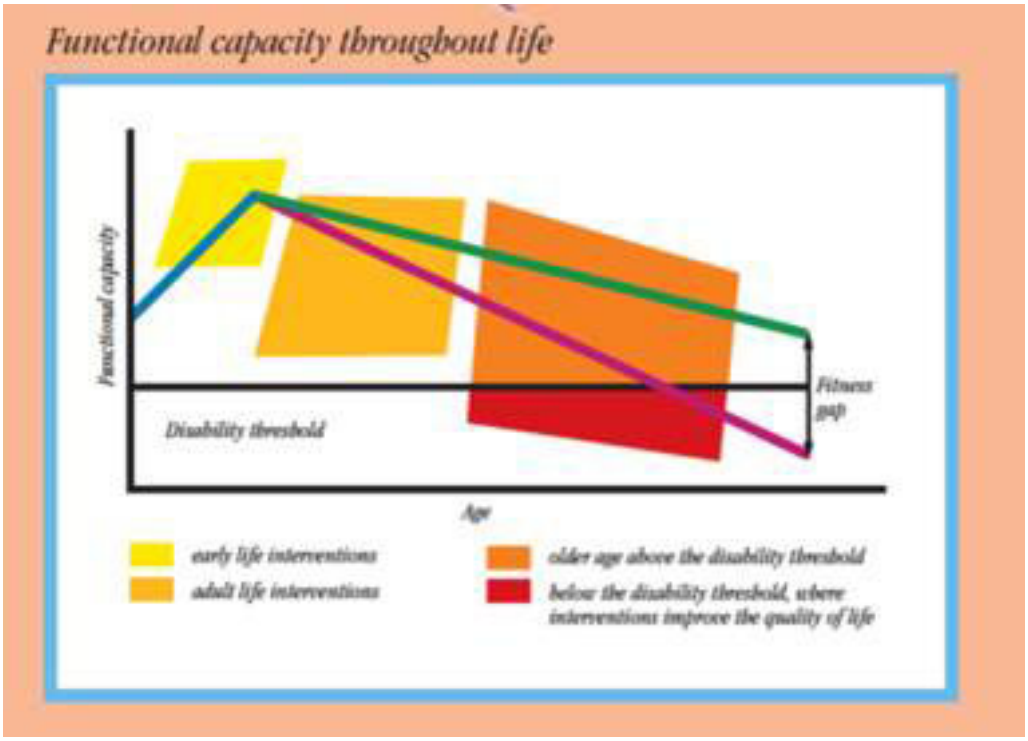

Figure 2 *WHO model of functional capacity throughout life (WHO, 1999:14)*

By 'slowing down' development and maintaining the functional capacity of a 20-year-old, it should be possible, according to P5, to delay the turning point – the climax – in the curve of life. In this period of life, 'where you can really excel' (P12, focus group 2, p. 28), the return for investment in fitness is maximised and you experience a positive feedback loop. This loop is de-regulated once the turning point of adulthood is reached. So, while it "does make sense if you're thirty and you're told that you have the physique of a twenty-five year-old" (P12, focus group 2, p. 28), in older ages, the expectations should be that of managed decline:

> You can workout in order to pump up your muscles, even if you are a bit older. So it is possible to cheat a bit (. . .) and you can probably keep doing that until you die, but then before you died you would have a bodyage of thirty-five or what? That doesn't really make sense either. (P12, focus group 2, p. 28)

In older ages, it is 'possible to cheat a bit'. The qualification of age modification as a form of minor deception is interesting because it points both to the physical and moral. As the return on investment in 'pumping your muscles' diminishes, the possibility of feigning a different body age identity is also less likely. This biosocial framing of the ageing process was in close connection with participants' pragmatism, discussed above. Their imaginary of the embodied life course offered a set of possibilities for action appropriate for a specific period in the 'curve of life', outside of which action would not 'really make sense'. Thus, the measure's main value was to provide a pragmatic positioning of the user in the 'curve of life'. This was powerfully encapsulated by one of the study's participants:

> [The measure shows that] physically I am able to do more than many might expect, when I have the age that I have. I think that it is nice that you can say physically that 'this thing, I can still do it' (P6, interview, p. 14).

The measure provided a 'reflexive opportunity' to re-enact the embodied self but within the constraints of the 'curve of life'. Therefore, the measure was most useful when it did not dis-align notably with those constraints. In this situation, it opened a space of actionability, it being possible to re-imagine one's functional capacity. This space of actionability, as was already argued, decreased with CA, so that the older one is the more likely it would be that BA and CA would coincide. In this situation, another repertoire of action would be more appropriate:

> Well, but if you are 95 [CA] and they say that you are 95 [BA], then there is probably not much that you can do. But you can try to talk to the great grandchildren and something like that. Maybe that could probably be good. (P9, focus group 1, p. 45).

The space of actionability enacted by the measurement was seen as pertaining only to physical or somatic capacities. Their decreasing malleability in older ages was seen by participants as a biological process that required appropriate pragmatic engagement with the body. It was, for example, important for participants to distinguish themselves from exercise or diet 'fanatics'. Such categorisation marked an important moral boundary relating to an age norm articulated by the study's participants: that level of exercise and other health maintenance practices should fit the individual's position in the trajectory of functional decline. The measurement, aligned with the shared imaginary of the life course, enacted this normativity in users' everyday lives bringing to bear age-appropriate physical health practices.

However, as the quote from P9 above makes clear, there were other age-related ways of acting and relating to others that did not entail engagement with one's own body. Here, the malleability of age identities was seen as wider and more long standing, age being defined as 'just a state of mind' (P6, interview, p. 13), and age being 'merely a number' (P19, interview, p. 15; P2, interview, p. 7). Participants thus contrasted the functional curve of life with the malleability of what social gerontologists have labelled 'subjective age' (Laslett 1989):

> I am still running around on the pavement trying to hit every line between the tiles, and then I am thinking, 'am I still 7 years old?'. (. . .) Age has become a fluid concept. (. . .) It might be that the number says I am 50, but we don't feel our age. (P6, interview, p. 13).

Contrasting the 'number' displayed on the age measuring instrument with how she feels, P6 was emphasising the importance of one's 'state of mind' for experience. This is illustrated by an age-inappropriate behaviour: hopping between tile lines while being middle-aged. It is in this sense that 'age has become a fluid concept'. This fluidity refers not only to the porosity of age-appropriate behaviours but, more importantly, to the ability to simultaneously inhabit two age norms, one enacted by the measurement of functional capacity, and the other brought to bear by the freedom to act according to 'inner feeling'. While those two normativities might appear contradictory, for participants they were complementary.

Health pragmatics and qualculation

The situated, evolving articulation between the three elements – the measurement, the embodied practice and the imaginary of the life course – is what we are proposing to conceptualise as a form of qualculation. As we have described, the participants in our study do not just accept the measure as an accurate gauge of their inner state or 'real age', but relate the quantification to their practice and imaginaries, and use it to deploy fragile self-classifications of present and future selves. In most cases, these classifications provide solidity to their self-

assessment of health, confirming participants' valuation of their embodied practice. In this situation, the measure gives an overall indication of whether you are 'on the right track' (P5, during interview, p. 18). As P18 put it, "even though I know that it doesn't really tell you anything real, I think it's supportive, yes" (P18, focus group 3, p. 22)

In most cases, the 'supportive' and 'unreal' qualities of the measure do not prompt participants to understand it or unlock its algorithm, even when the measure does not give the expected result (see deviant case analysis, illustration 1). The measure is pragmatically assessed through various factors such as previous diseases, as we showed above with P8. The age measure is part of a health engagement in which several factors play in, and the number in itself plays a part in a logic that is transient, fragile and equipped by qualitative points of reference (diseases, 'cracks on heels', relations, work and family histories) and mundane objects and events (food, scales, GP appointments and fitness routines).

Thus, the qualculatable space is usually not one of maximisation of function or health utility. Rather, participants engage with the measure through a constant valuation of the speed at which they decline on the model relating functional capacity with age. But it is not the quantification alone that matters, rather it is the process of qualculation that generates alternative, differently affected futures: older selves which cannot be fully avoided but deferred and eased into. This process requires a 'to and fro' process between the BA measurement and the reckoning of embodied practices, their efficacy and effects and an assessment of the time and direction travelled after the measurement. Participants open and maintain the possibility of an old age in physical, mental and emotional vigour but only within the slope of decline that accompanies ageing, when it 'goes downhill physiologically'.

Because of the relative stability provided by the model, the qualculation works to reinforce the positive feedback loop between BA and participants' experiences of their embodied practices. However, as shown in the deviant case analysis, when this positive feedback loop is broken, the quantification fails to support users' qualculated selves. Health qualculation then, as we proposed above, is the fragile and transient outcome of a configuration of social and material elements.

It is our suggestion that other studies focused in quantified health practices would gain from drawing on the notion of qualculation. As we have argued above, the concept of qualculation enabled us to understand why, despite being sceptical of the validity of the age measurement, users were still able to make it pragmatically meaningful. Instead of positioning users as either 'technological dupes' or 'active resisters', the concept of qualculation led our analysis to seek to understand the conditions underpinning a particular form of health pragmatics, supported by fuzzy information, embodied knowledge and an imaginary of the life course. We expect that other forms of quantification, in other health contexts, will generate different forms of qualculation, supported by different configurations of elements.

The concept of health qualculation can also be of use to understand and improve public health programmes that rely on providing 'BA' personalised measurement to support or motivate lifestyle changes, such as the NHS' 'What's your heart age?' tool (https://www.nhs.uk/conditions/nhs-health-check/check-your-heart-age-tool/, assessed 18 November 2019). Our study suggests that such tools might only be useful to positively reinforce already existing 'healthy' practices. Given the composition of our sample, we were only able to glimpse onto the dynamics that are deployed in cases where age measurement differs from users' own assessment of their health. However, our deviant case provides clues for further research on the role of health quantification in the production of shame and/or stigma. It is important to investigate whether specific and/or disadvantaged groups would be better supported in their health practices by other, non-quantified kinds of information.

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Authors' contributions

Tiago Moreira contributed to conceptualization-lead; data curation-supporting, formal analysis-equal, funding acquisition-equal; investigation-supporting; methodology-lead; project administration-supporting; writing-original draft-supporting; writing-review & editing-equal. **Aske Lassen** contributed to conceptualization-supporting; data curation-lead; formal analysis-equal; funding acquisition-equal; investigation-equal; methodology-equal; project administration-lead. **Asger Aarup Hansen** contributed to conceptualization-supporting; data curation-equal; formal analysis-equal; funding acquisition-supporting; investigation-lead; methodology-equal; project administration-supporting.

Data availability

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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