Original Article

Change in body weight of older adults before and during the COVID-19 pandemic: longitudinal results from the Berlin Aging Study II

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ABSTRACT

Objectives: Change in body weight during the COVID-19 pandemic as an unintended side effect of lockdown measures has been predominantly reported for younger and middle-aged adults. However, information on older adults for which weight loss is known to result in adverse outcomes, is scarce. In this study we describe the body weight change in older adults before, during, and after the COVID-19 lockdown measures and explore putative associated factors with a focus on the period that includes the first six months of the COVID-19 containment measures.
Design: Prospective cohort study with three follow-up examinations over the course of 10 years.
Setting and Participants: In this study, we analyzed the longitudinal weight change of 472 participants of the Berlin Aging Study II (mean age of 67.5 years at baseline).
Measurements: Body weight was assessed at four time points. Additionally, differences between subgroups characterized by socio-economic, cognitive, and psychosocial variables as well as morbidity burden, biological age markers (epigenetic clocks, telomere length), and frailty were compared.
Results: On average, women and men lost 0.87% (n = 227) and 0.5% (n = 245) of their body weight per year in the study period covering the first six months of the COVID-19 pandemic. Weight loss among men was particularly pronounced among groups characterized by change in physical activity due to COVID-19 lockdown, low positive

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affect, premature epigenetic age (7-CpG clock), diagnosed metabolic syndrome, and a more masculine gender score (all variables: $p < 0.05$, n = 245).

Conclusion: During the COVID-19 pandemic, older participants lost weight with a 2.5-times (women) and 2-times (men) higher rate than what is expected in this age.

1. Introduction

The outbreak of the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was declared to be a public health emergency of international concern on January 30th, 2020, by the World Health Organization (WHO) [1]. To contain its spread, non-pharmaceutical interventions (NPIs) were implemented by governments across the world [1–3] as numbers of cases and deaths were rising. They included, among others, closing of schools, social distancing, and lockdowns on the population level [4]. In Berlin, Germany, the first SARS-CoV 2 positive patient was registered on March 1st, 2020. Gradually increasing restrictions were subsequently imposed in Berlin and culminated in the first full lockdown in mid-March and April 2020 [5,6]. A second lockdown was in effect between November 2020 and April 2021. However, the degree of restrictions varied within and across the lockdown periods and different rules applied to persons with a negative SARS-CoV-2 test.

While lockdowns proved, at least for the most part, to be effective in keeping the number of SARS-CoV-2 infections low [3,4,7], other effects of NPIs, both beneficial and adverse, were reported. For example, while unfavorable nutritional habits (e.g., an increase in consumption of comfort food and alcohol) seemed to be predominant, beneficial dietary changes (e.g., increased consumption of fresh produce and home cooking) were also reported (reviewed in [8] and [9]). Body weight was one important anthropometric measure that was potentially impacted by these changes in dietary behavior, but potentially also by psychosocial

stress, mobility restrictions, individual predispositions, and other factors associated with social restrictions or COVID-19 itself [8,10–15]. To quantify this effect, several studies analyzing body weight during the time of the COVID-19 pandemic and associated lockdown measures have been published (reviewed in [9,14,15,16]). However, almost all of these studies (except for [10,17]) relied on cross-sectional data only. Furthermore, only two studies examined older adults, here defined as individuals with a mean age above 65 years [11,17]. This type of data are needed because earlier reports have demonstrated both an increase of malnutrition during lockdown measures among older adults [17] and that low body weight [18] and especially weight loss [18,19] are associated with higher mortality in this vulnerable group (obesity paradox [18]).

In this study, we aimed to close this knowledge gap by describing the longitudinal change of body weight in participants of the Berlin Aging Study II (BASE-II [20]) before, during, and after the time COVID-19 lockdown measures were implemented. In a second step, we exploratively analyzed differences in body weight change between subgroups characterized by variables known or hypothesized to be associated with healthy aging or body weight. Availability of comprehensive clinical, phenotypic, and molecular data assessed at four timepoints, of which one assessment was completed directly before the onset of the COVID-19 pandemic, is a unique feature of BASE-II. This allowed us to study the weight change of older adults over more than ten years of follow-up including the period of the first months of lockdown measures.
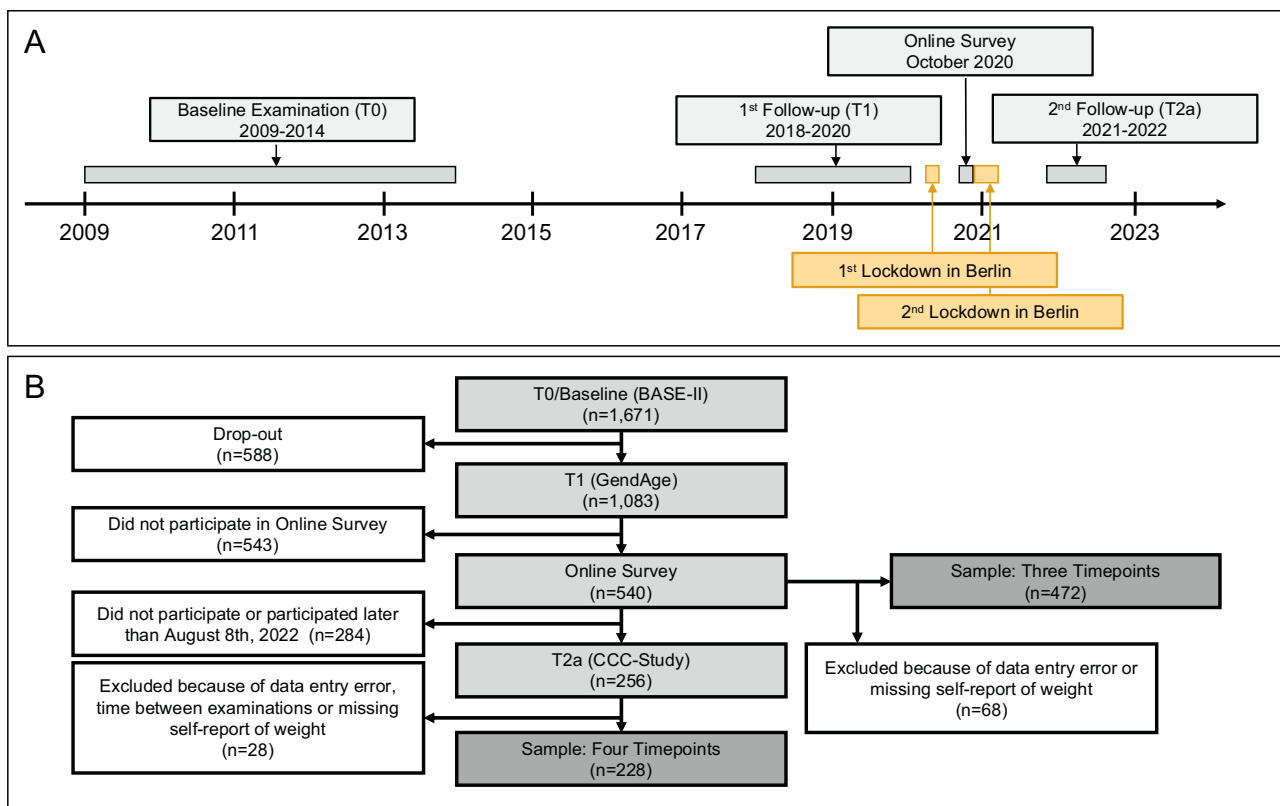

Fig. 1. (A) Timeline visualizing baseline, first follow-up examination, Online Survey and second follow-up examination of the BASE-II cohort. (B) Flowchart illustrating how the final sample including three and four timepoints was defined.

2. Methods

2.1. Study population

The Berlin Aging Study II (BASE-II) is a multicenter interdisciplinary study with the goal to identify health-promoting factors in old age [20]. Baseline examination (T0) of 1,671 older participants in the medical part of the study (mean age $+/-$ SD: 68.8 $+/-$ 3.7 years, 51.6% women) was conducted between 2009 and 2014. Between 3.9 and 10.4 years later (mean $+/-$ SD: 7.4 $+/-$ 1.5 years) a follow-up examination of 1,083 participants ($+$17 additional participants) as part of the GendAge study (T1) [21] was conducted. This examination (T1) took place between June 22nd 2018 and March 10th 2020, thereby was completed shortly before the start of local COVID-19-restrictions. Six months into the COVID-19 pandemic an online survey was sent out to the participants. At the time the online survey was conducted, none of the participants reported to have had COVID-19 since the beginning of the pandemic. In the final dataset, 472 participants provided information on their body weight at T0, T1 and online survey (Fig. 1).

A second medical follow-up examination (T2) began in February 2021 and was completed in July 2023 as part of the Charité Corona Cross study. Because we focused on COVID-19-pandemic lockdown associated changes in this study, we included only participants who were examined before August 8th, 2022 (T2a) in our analyses. However, this choice was arbitrary as no meaningful cut-off is available. A sample of 228 participants was available that provides information on all four time-points (T0, T1, online survey, and T2a, see Fig. 1).

Potential bias due to non-random loss to follow-up was examined (Supplementary Table S1). If any, only very limited selection bias is observable in the variables examined here.

This manuscript was created in accordance with the STROBE guidelines [22,23].

2.2. Body weight

Participants were asked to report their body weight as part of a questionnaire (in kilogram with one or no decimal places). Additionally, body weight was measured at T0 and T1 (after the self-reported weight has been recorded) with the electronic measuring station seca 763 (SECA, Germany) in kilogram with two decimal places. To improve comparability between all four timepoints, the self-reported weight was used for all subsequent analyses. The participant's individual weight change between two consecutive timepoints was calculated as annual percentage change making use of an exponential growth function known as compound annual growth rate (CAGR):

$$CAGR(t_0, t_1) = \left(\left(\frac{w_1}{w_0} \right)^{\frac{1}{t_1 - t_0}} - 1 \right) * 100$$

where w_0 is the initial weight (in kg) at timepoint t_0 which is followed by the consecutive measurement of body weight w_1 at timepoint t_1. The time difference between body weight assessments $t_1 - t_0$ was calculated as difference between age in years at time of assessment.

2.3. Additional variables

All additional variables, except self-reported change in physical activity (PA) due to COVID-19, were assessed at the first follow-up examination (T1) that was completed just before the pandemic started. A more in-depth description on how these variables were assessed can be found in the Supplementary Methods. As the variables are analyzed on different scales and different variable types (continuous, categorical, and binary) are present in the dataset, we chose to dichotomize the analyzed variables to allow for an easy and more intuitive comparison and alleviate interpretation. Respective method of dichotomization as well as cut-off

values, if applicable, are summarized in Supplementary Table S2. Variables were chosen based on availability and representation of the following domains: general characteristics, physical activity, cognitive performance, frailty, chronic disease, biomarkers of aging, and psychosocial variables. All variables are analyzed exploratively and no final conclusions of the independency of these findings from potential confounders can be drawn without additional external validation.

General Characteristics: Biological sex was assessed dichotomously as "man" or "women". To separate the effects of socially constructed gender from sex a "gender score" was recorded. This score aggregates information on central gender dimensions. Lower values indicate more traditionally male characteristics (for more details see [24]). Cohabitation was derived from several questions about the participant's household and living situation (further information in Supplementary Methods). BMI at T1 was calculated as measured weight (in kg) divided by squared height (in m). Education was measured in number of years (7–18 years). Income was assessed in eighteen categories as part of the self-administered questionnaire.

Physical Activity (PA): Participants were asked to rate themselves as "active" or "rarely/never active" (reported as "not active" of the variable "Physically Active" in this study) as part of the Rapid Assessment of Physical Activity (RAPA) [25] questionnaire. Additionally, PA was measured with the wGT3X-BT activity monitor (ActiGraph LLC, USA) and reported as Vector Magnitude (VM) count [26]. Participants were asked to report change in their PA that specifically needs to be attributed to the COVID-19 pandemic as part of the online survey six months into the pandemic.

Cognitive performance, Hand Grip Strength and Frailty: Cognitive performance, specifically perceptual speed, was assessed by the Digit Symbol Substitution Test (DSST) [27]. Muscle strength was assessed as hand grip strength, and pre-specified cut-off values were used to define impairment [28,29]. Frailty indices were calculated following the approach by Fried and colleagues [29] as well as the deficit accumulation approach implemented in the SPRINT study [30].

Cardiovascular Risk and Chronic Disease: Ten-year risk for cardiovascular disease was calculated with the SCORE2 and SCORE2-OP instrument [31,32] (hereinafter referred to as SCORE2). Type 2 Diabetes Mellitus (T2D) was diagnosed based on the criteria defined by the American Diabetes Association (ADA) guidelines [33]. Metabolic syndrome was diagnosed according to the American Heart Association/International Diabetes Federation/ National Heart, Lung, and Blood Institute criteria 2009 [34]. Kidney function was determined by estimating the glomerular filtration rate (eGFR) based on cystatin C using the CAPA equation [35]. To get a more general estimation of the participants morbidity, an adapted version [36] of Charlson's morbidity index [37] was calculated.

Biomarkers of Aging: The 7-CpG clock [38] and GrimAge clock [39] DNA methylation age (DNAmA) were measured in EDTA blood samples collected at the first follow-up. DNAmA acceleration (DNAmAA) was calculated as leukocyte-adjusted residuals of a linear regression of DNAmA on chronological age (for details please [40]). Telomere length was estimated with a recently published algorithm from epigenome-wide methylation data [41].

Psychosocial Resources: Affect was assessed by the Positive and Negative Affect Schedule (PANAS-X [42,43]). The UCLA Loneliness Scale [44] was used to assess loneliness [45]. A 3-item subscale of the short version of the Big Five Inventory (BFI) [46] was used to assess conscientiousness [47]. Perception of stress was assessed by eight items of the Perceived Stress Scale (PSS) [48]. Participants answered the questions on a scale from 1 ("never") to 5 ("very often").

2.4. Missing values

In the final dataset, 5.2% of data was missing and subsequently imputed with R's mice package [49] (20 imputed datasets, 5 iterations).

Table 1
Descriptive statistics of age and body weight of the subsample of BASE-II participants that provided information at all four timepoints (n = 228). T-tests are used to assess statistical differences between men and women.

Timepoint	Variable	Women (n = 111)				Men (n = 117)				
		mean	sd	min	max	mean	sd	min	max	p-value
T0	Age (years)	67.01	2.71	61.30	73.30	67.64	3.39	60.40	77.30	0.122
	Body weight (kg)	67.49	11.27	49.00	103.30	81.99	10.60	60.50	120.00	<0.001
T1	Age (years)	74.64	3.08	67.10	82.70	74.58	3.80	65.80	85.90	0.895
	Body weight (kg)	67.01	11.35	43.00	106.00	80.40	10.62	60.00	117.00	<0.001
Online Survey	Age (years)	76.10	3.05	68.60	83.60	76.10	3.79	68.20	87.70	0.994
	Body weight (kg)	66.30	11.54	45.00	100.00	80.12	10.31	60.00	115.00	<0.001
T2a	Age (years)	77.40	2.98	70.20	85.20	77.37	3.59	69.80	88.80	0.952
	Body weight (kg)	66.24	11.39	43.00	103.00	80.40	11.01	61.00	130.00	<0.001
T0 to T1	Body weight change (kg)	−0.48	3.59	−10.00	6.50	−1.59	5.32	−21.50	15.50	0.068
	Body weight change per year (kg/year)	−0.07	0.51	−1.70	1.20	−0.21	0.75	−3.10	2.50	0.106
	Body weight change CAGR (%)	−0.11	0.77	−2.90	1.90	−0.26	0.91	−3.30	3.20	0.170
T1 to Online Survey	Body weight change (kg)	−0.71	2.79	−11.00	7.00	−0.27	3.52	−19.00	13.00	0.300
	Body weight change per year (kg/year)	−0.48	2.06	−6.80	6.60	−0.29	2.65	−16.10	12.90	0.563
	Body weight change CAGR (%)	−0.74	3.08	−10.20	9.40	−0.25	3.42	−17.70	21.80	0.259
Online Survey to T2a	Weight change (kg)	−0.06	2.74	−14.00	10.00	0.28	3.76	−13.00	20.00	0.446
	Weight change per year (kg/year)	−0.05	2.15	−10.30	7.80	0.66	4.88	−8.20	43.20	0.159
	Weight change CAGR (%)	−0.02	3.10	−13.80	12.10	0.93	7.37	−8.60	72.10	0.212

Convergence of the imputation algorithm as well as distribution and proportions of imputed variables were inspected visually. As part of a sensitivity analysis, we re-ran our models using the original (not-imputed) dataset which revealed a highly comparable pattern of results (Supplementary Figs. S1 and S2).

2.5. Statistical analyses

All statistical analyses were conducted in R, version 4.2.1 [50] and figures were drawn with R's "ggplot2" package [51]. Mean difference between groups as well as 95% confidence intervals and p-values for two-sided two-sample t-tests were calculated to assess statistical significance of between group differences. Continuous variables were dichotomized to allow a more easy and intuitive comparison. A p-value <0.05 was defined as statistically significant.

3. Results

3.1. Participants

In this study we analyzed 472 BASE-II participants that provided information on their body weight at three timepoints. After the baseline examination (2009–2014, T0), the first follow-up examination (T1) was conducted on average 7.4 years later and was completed just before the beginning of the pandemic. The third data assessment was conduct as an online survey six months into the pandemic. To examine how the weight of the participants developed subsequently, we analyzed a subsample of 228 participants who were followed-up a fourth time on average about 1 year later (T2a).

Mean age at T0, T1, online survey, and T2a were 67.5, 74.8, 76.3, and 77.4 years (Table 1, Supplementary Table 3). About half of the study sample are women (48%). Follow-up time between T0 and T1, T1 and online survey, and online survey and T2a were 7.3, 1.5, and 1.1 years. Self-reported and measured weight correlated highly at T0 (r = 0.98) and at T1 (r = 0.99, Fig. 2B and C), suggesting a high degree of comparability between self-reported and objectively measured weight.

3.2. Change in body weight

Mean change of body weight per year in percent (compound annual growth rate, CAGR) between T0 and T1 was −0.17% for men and −0.04% for women (Supplementary Table S3). Between T1 and the online survey (mean follow-up time +/− SD: 1.5 +/− 0.47 years), which is the period that covers the first six months of the COVID-19 pandemic in Berlin as well as associated lockdown measures and restrictions, men lost on average 0.5% and women lost on average 0.87% of their body weight per year (Supplementary Table 3). In the period following the online survey in which lockdown measures were generally less strict, men gained 0.93% of body weight while women continued to lose on average 0.02% per year (Table 1, Fig. 3). Descriptive statistics of the sample of participants who provided data at only three time points (n = 472) is provided in Supplementary Table S3.

Only very few participants switched weight quartiles between T1, Online Survey, and T2a. This indicates that the weight changes between timepoints were not the result of extreme changes of only a few individuals but result from the change of the whole study population (Supplementary Fig. S3).

Cross-sectionally, age was not correlated with body weight in men (r ≤ 0.05) and only modestly correlated in women (r = −0.2, Supplementary Fig. S4B). Individual weight trajectories are visualized in Supplementary Fig. S4A.

3.3. Comparison of change in body weight between specific subgroups

To further explore changes in body weight, in a first step we analyzed differences between participants who reported to have changed their physical activity levels due to COVID-19 lockdown measures assessed in an online survey six months into the COVID-19 epidemic and those who reported no change. While no statistically significant weight change differences were found in women (ANOVA, p = 0.47), men who reported to have increased (mean = −1.5%, n = 18) and reduced PA (mean = −1.2%, n = 69) differed statistically significantly in their weight change (CAGR) from men who reported to not have changed their PA (mean = −0.1%, n = 157) due to COVID-19 lockdown measures (Fig. 2A).

In a second step we aimed to describe differences in body weight change between subgroups that were defined by variables assessed at the first follow-up examination which was completed just before the first COVID-19 lockdown measures were implemented (T1). Descriptive statistics of analyzed variables can be found in Supplementary Table S1.

In women no statistically significant difference between weight change was found when comparing subgroups. Male participants with lower values in positive affect, premature biological aging (7-CpG epigenetic clock), diagnosed metabolic syndrome, and a lower gender score (more masculine) lost significantly more weight than participants in the comparison group (Fig. 4).
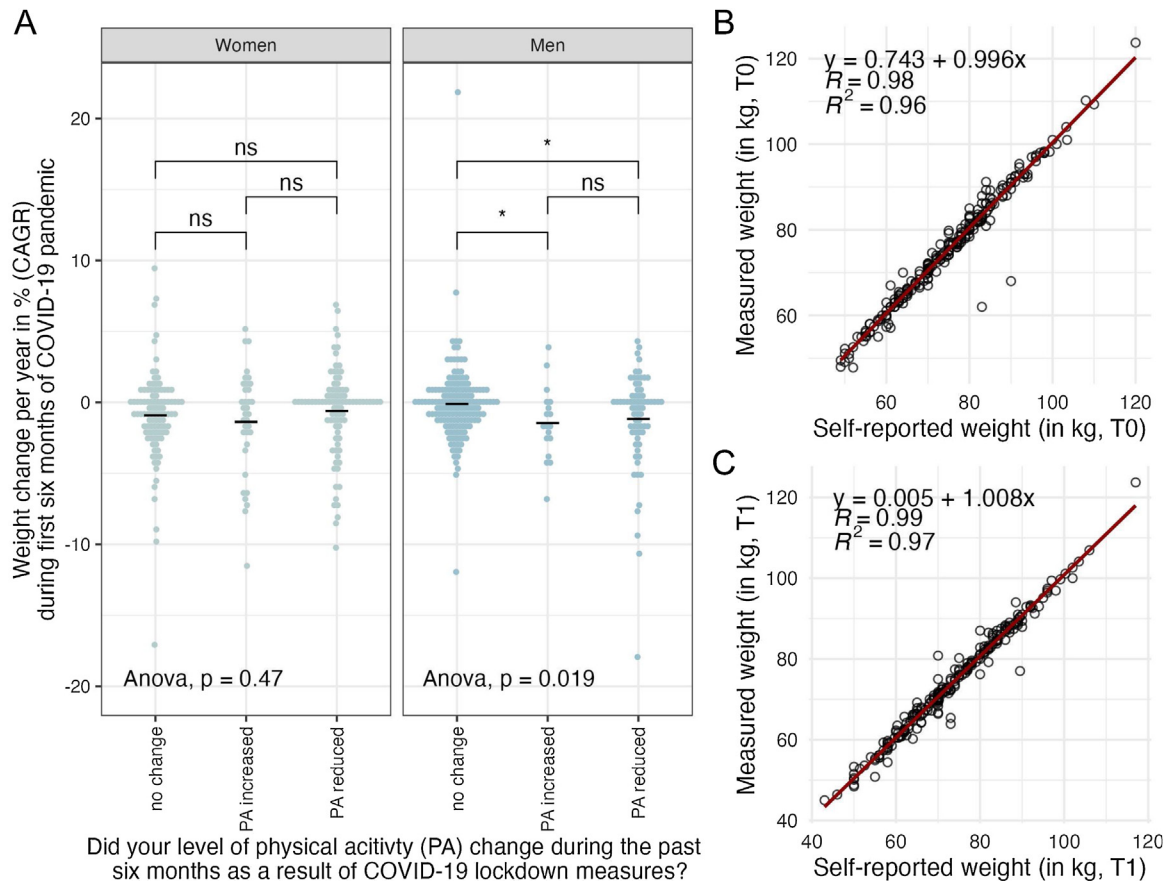
Fig. 2. (A) Boxplot displaying the difference in weight change stratified by self-reported change in physical activity during the first six months of COVID-19 lockdown. (B and C) Scatterplots illustrating the high correlation between measured and self-reported weight during baseline (T0) and first follow-up (T1) examination. Note: kg: kilogram; CAGR: compound annual growth rate, T0: baseline examination, T1: first follow-up examination.

The combined analysis of women and men is shown in Supplementary Figures S5 and S6. Additionally, Pearson's correlations coefficients between weight change (between T1 and online survey) and continuously measured variables of interest at T1 are shown in Supplementary Figure S7.

4. Discussion

In this study, we assessed the change in body weight before, during and after COVID-19 lockdown measures in an otherwise healthy older people (age >65years) cohort from Berlin, Germany. Weight loss in the period covering the first six months of the COVID-19 pandemic was 2.5-times (−0.71 kg, women) and 2-times (−0.27 kg, men) higher than expected in this age group according to a large dataset of participants from Austria (n = 185,192 [52]). Interestingly, after the initial six months of the pandemic, the women's weight was almost stable (on average −0.02% of body weight per year) and men even gained on average 0.93% of body weight per year eventually reaching their average body weight that was assessed at the examination prior to the pandemic (Table 1). A lower than expected body weight is of concern because it was shown to be associated with increased mortality [18]. Furthermore, unintended weight loss is part of the well-established Fried frailty phenotype [29].

Our findings contrast with the only other study examining a healthy study sample with a mean age of more than 65 years. DiSanto and colleagues who found in a survey conducted with 128 participants between 60 and 87 years that 35% reported weight gain and 11% reported weight loss during the time COVID-19 containment measures were in

place [11]. One recent systematic review on the change of body weight and BMI during the first COVID-19 lockdown period identified 36 eligible studies [14]. The authors of the systematic review suggested that the focus on younger people in the literature might be the result of the data collection and recruitment methods which were predominantly online and therefore potentially were less accessible for older adults [15]. This illustrates that, although this topic is of high interest, data on the group of older adults is scarce.

In a second step, we compared changes in body weight between different subgroups in our sample. Men who reported to have changed their PA (either increased or reduced PA) due to COVID-19 lockdown measures had lost significantly more body weight compared to those who did not change their PA levels. Furthermore, statistically significant differences in body weight change were found for men between groups characterized by positive affect, epigenetic age (7-CpG clock), metabolic syndrome and the gender score. We note that these findings result from explorative analyses, and therefore cannot be used for prediction or causal inferences without further independent validation.

There are several limitations to this study. First, as with every longitudinal study, evaluation of potential bias due to loss to follow-up poses a challenge. However, a comparison of the subsample of participants providing information at all three timepoints (n = 472) with the complete sample at baseline shows no large deviation (Supplementary Table S1). Furthermore, a multiple imputation approach was employed to limit additional loss of observations due to missing values. Nevertheless, the sample analyzed in this study is slightly healthier and generally less impaired compared to participants who were not included in the second follow-up. Therefore, the results presented
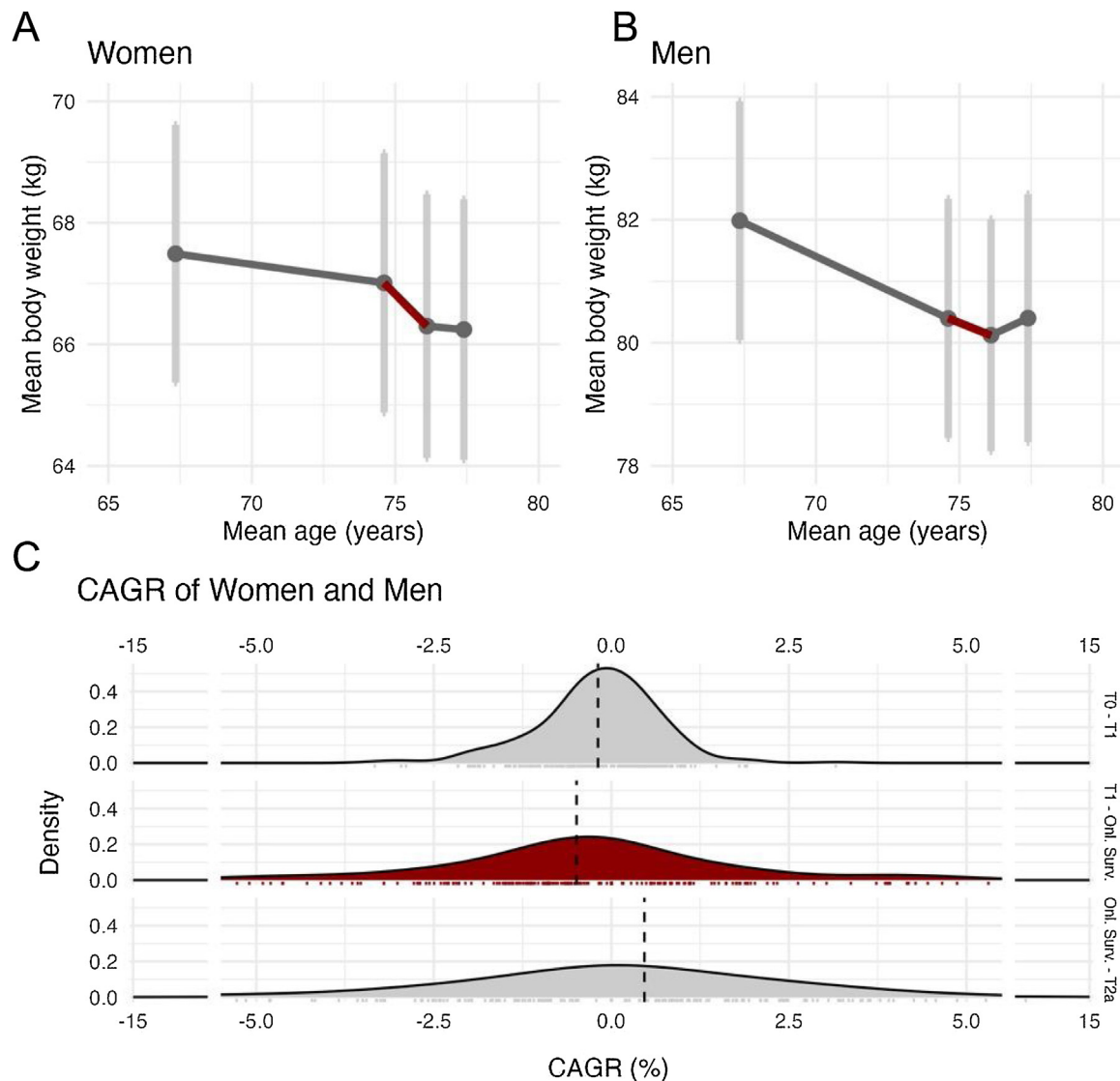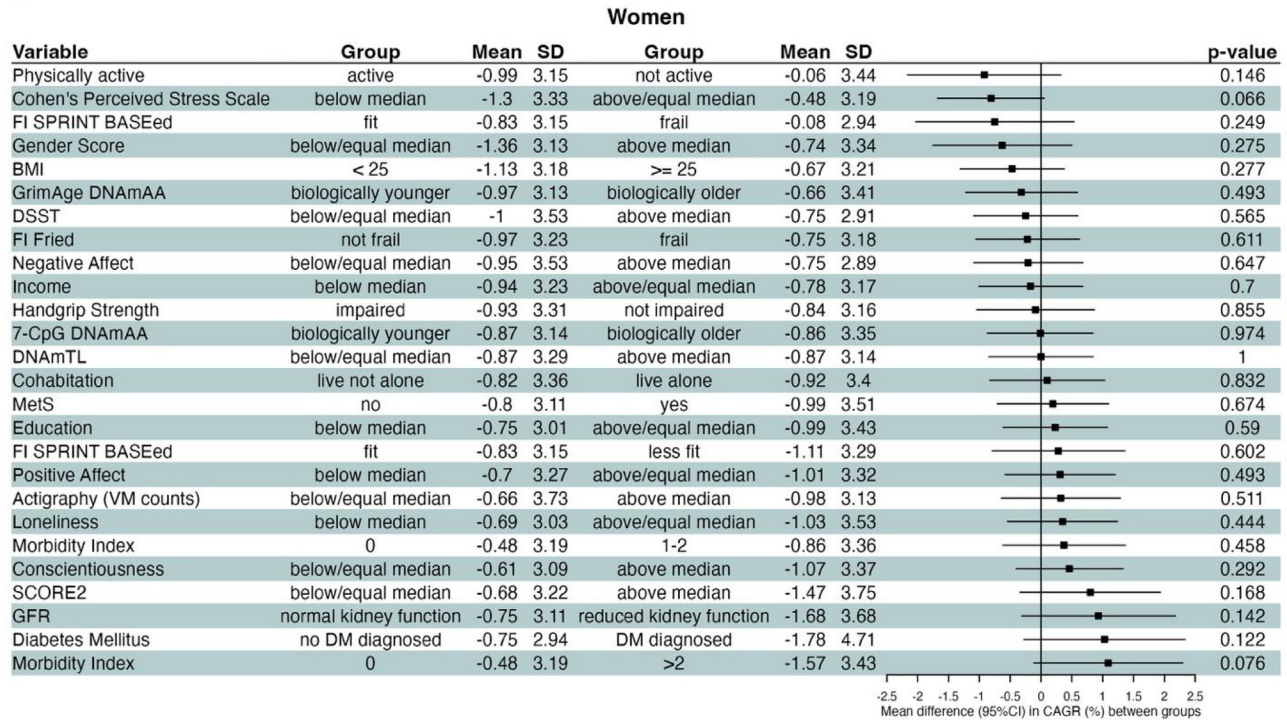
Fig. 3. Mean and 95% CI of BASE-II participants body weight at T0, T1, online survey, and T2a (n = 227) stratified for subgroups of women (A) and men (B). Statistical significance of weight difference between timepoints was tested with one-sample t-test. Women: T0-T1: p = 0.163, T1-Online Survey: p = 0.008, Online-Survey-T2a: p = 0.828. Men: T0-T1: p = 0.002; T1-Online Survey: p = 0.405; Online Survey-T2a: p = 0.426. Density curves of CAGR (Change in body weight per year in percent) between T0/T1, T1/ Online Survey, and Online Survey/T2a for women and men (C). Note: kg: kilogram; CAGR: compound annual growth rate, T0: baseline examination, T1: first follow-up examination; Onl. Surv.: Online Survey; T2a: second follow-up examination.

here potentially underestimate the real effect size. Second, although body weight of participants was measured with an electronic scale at T0 and T1, only self-reported body weight was available at all four timepoints. We note though that the correlation between objectively measured and self-reported weight (which was recorded before body weight was measured) at T0 and T1 was very high ($r \geq .98$). At the same time, we cannot rule out context effects. At the study site, participants may have reported more accurate weights because they expected a subsequent objective assessment, whereas it was clear to them that the online questionnaire would not involve any objective verification. Therefore, it is possible that although the degree of agreement between self-reported and measured weight was very high for baseline and follow-up, this does not necessarily have to be the case at the other two timepoints. A third limitation to this study is the above-average health, educational level and income of this particular cohort as described before [20] limiting the generalizability of the results. Furthermore, participants of BASE-II might have access to coping strategies that are not available to other parts of the population,

which potentially results in an underestimation of the adverse effects observed in this study. Fourth, because of the explorative nature of our analyses, we did not adjust for multiple testing. Additionally, the analyses were not adjusted for confounding variables. Therefore, no conclusions on the independency of the reported effects from potential confounders can be drawn without an independent validation of our results. Nevertheless, the results presented here can aid future studies with a larger sample size that aim at the examination of causal relationship or at the development of prediction models by potentially informing the variable selection.

Strengths of this study include the well characterized large cohort of older adults. The high quality of assessed data at four examinations of which the second just ended before the first COVID-19 cases were reported in Berlin allows a detailed description of weight change. Additionally, the wide range of variables that is available in the BASE-II allows a comprehensive explorative analysis of different aspects and individual levels of functionality.
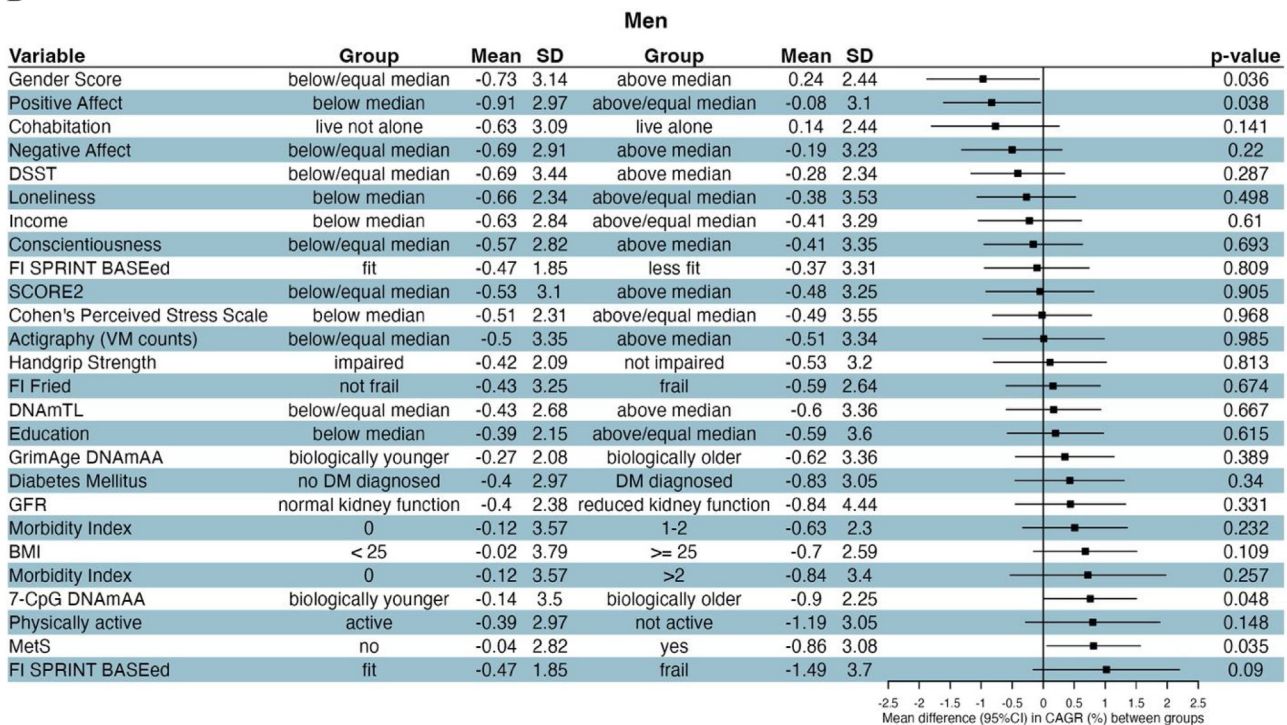
A

Women

Variable	Group	Mean	SD	Group	Mean	SD	p-value
Physically active	active	-0.99	3.15	not active	-0.06	3.44	0.146
Cohen's Perceived Stress Scale	below median	-1.3	3.33	above/equal median	-0.48	3.19	0.066
FI SPRINT BASEed	fit	-0.83	3.15	frail	-0.08	2.94	0.249
Gender Score	below/equal median	-1.36	3.13	above median	-0.74	3.34	0.275
BMI	< 25	-1.13	3.18	>= 25	-0.67	3.21	0.277
GrimAge DNAmAA	biologically younger	-0.97	3.13	biologically older	-0.66	3.41	0.493
DSST	below/equal median	-1	3.53	above median	-0.75	2.91	0.565
FI Fried	not frail	-0.97	3.23	frail	-0.75	3.18	0.611
Negative Affect	below/equal median	-0.95	3.53	above median	-0.75	2.89	0.647
Income	below median	-0.94	3.23	above/equal median	-0.78	3.17	0.7
Handgrip Strength	impaired	-0.93	3.31	not impaired	-0.84	3.16	0.855
7-CpG DNAmAA	biologically younger	-0.87	3.14	biologically older	-0.86	3.35	0.974
DNAmTL	below/equal median	-0.87	3.29	above median	-0.87	3.14	1
Cohabitation	live not alone	-0.82	3.36	live alone	-0.92	3.4	0.832
MetS	no	-0.8	3.11	yes	-0.99	3.51	0.674
Education	below median	-0.75	3.01	above/equal median	-0.99	3.43	0.59
FI SPRINT BASEed	fit	-0.83	3.15	less fit	-1.11	3.29	0.602
Positive Affect	below median	-0.7	3.27	above/equal median	-1.01	3.32	0.493
Actigraphy (VM counts)	below/equal median	-0.66	3.73	above median	-0.98	3.13	0.511
Loneliness	below median	-0.69	3.03	above/equal median	-1.03	3.53	0.444
Morbidity Index	0	-0.48	3.19	1-2	-0.86	3.36	0.458
Conscientiousness	below/equal median	-0.61	3.09	above median	-1.07	3.37	0.292
SCORE2	below/equal median	-0.68	3.22	above median	-1.47	3.75	0.168
GFR	normal kidney function	-0.75	3.11	reduced kidney function	-1.68	3.68	0.142
Diabetes Mellitus	no DM diagnosed	-0.75	2.94	DM diagnosed	-1.78	4.71	0.122
Morbidity Index	0	-0.48	3.19	>2	-1.57	3.43	0.076

-2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2.5
Mean difference (95%CI) in CAGR (%) between groups

B

Men

Variable	Group	Mean	SD	Group	Mean	SD	p-value
Gender Score	below/equal median	-0.73	3.14	above median	0.24	2.44	0.036
Positive Affect	below median	-0.91	2.97	above/equal median	-0.08	3.1	0.038
Cohabitation	live not alone	-0.63	3.09	live alone	0.14	2.44	0.141
Negative Affect	below/equal median	-0.69	2.91	above median	-0.19	3.23	0.22
DSST	below/equal median	-0.69	3.44	above median	-0.28	2.34	0.287
Loneliness	below median	-0.66	2.34	above/equal median	-0.38	3.53	0.498
Income	below median	-0.63	2.84	above/equal median	-0.41	3.29	0.61
Conscientiousness	below/equal median	-0.57	2.82	above median	-0.41	3.35	0.693
FI SPRINT BASEed	fit	-0.47	1.85	less fit	-0.37	3.31	0.809
SCORE2	below/equal median	-0.53	3.1	above median	-0.48	3.25	0.905
Cohen's Perceived Stress Scale	below median	-0.51	2.31	above/equal median	-0.49	3.55	0.968
Actigraphy (VM counts)	below/equal median	-0.5	3.35	above median	-0.51	3.34	0.985
Handgrip Strength	impaired	-0.42	2.09	not impaired	-0.53	3.2	0.813
FI Fried	not frail	-0.43	3.25	frail	-0.59	2.64	0.674
DNAmTL	below/equal median	-0.43	2.68	above median	-0.6	3.36	0.667
Education	below median	-0.39	2.15	above/equal median	-0.59	3.6	0.615
GrimAge DNAmAA	biologically younger	-0.27	2.08	biologically older	-0.62	3.36	0.389
Diabetes Mellitus	no DM diagnosed	-0.4	2.97	DM diagnosed	-0.83	3.05	0.34
GFR	normal kidney function	-0.4	2.38	reduced kidney function	-0.84	4.44	0.331
Morbidity Index	0	-0.12	3.57	1-2	-0.63	2.3	0.232
BMI	< 25	-0.02	3.79	>= 25	-0.7	2.59	0.109
Morbidity Index	0	-0.12	3.57	>2	-0.84	3.4	0.257
7-CpG DNAmAA	biologically younger	-0.14	3.5	biologically older	-0.9	2.25	0.048
Physically active	active	-0.39	2.97	not active	-1.19	3.05	0.148
MetS	no	-0.04	2.82	yes	-0.86	3.08	0.035
FI SPRINT BASEed	fit	-0.47	1.85	frail	-1.49	3.7	0.09

-2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2.5
Mean difference (95%CI) in CAGR (%) between groups

Fig. 4. Forest plot of mean difference and 95% CI between CAGR (%) between groups defined by general characteristics, physical activity, geriatric assessments, chronic disease, biomarkers of aging, and psychosocial parameters. Note: DSST: Digit Symbol Substitution Test; DNAmAA: DNA methylation age acceleration; DNAmTL: DNA methylation telomere length; VM: Vector Magnitude; GFR: glomerular filtration rate; BMI: Body Mass Index; MetS: Metabolic Syndrome; FI: Frailty Index; CAGR: compound annual growth rate.

5. Conclusion

Change in body weight in the study period covering the first 6 months of the COVID-19 pandemic were about 2.5- (women) and 2-times (men) higher than what would be expected in this age group. Body weight change in men differed statistically significantly between subgroups characterized by change of PA due to COVID-19 lockdown, positive affect, biological age (7-CpG clock), metabolic syndrome, and gender score. Although these descriptive results need to be validated independently, they point to interesting candidate markers for future studies.

Author contributions

Conceived and designed the study: V.M.V and I.D. Contributed study-specific data: V.M.V., J.D., S.D., J.H., J.B. L.M.-A., A.P., F.K., G.G.W., A.T., L.B., V.R.-Z., D.G. and I.D. Analyzed the data: V.M.V. Wrote the manuscript: V.M.V and I.D. All authors revised and approved the manuscript.

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Ethics approval and consent to participate

All participants gave written informed consent. All medical assessments were conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the Charité – Universitätsmedizin Berlin (approval numbers EA2/029/09, EA2/144/16, and EA2/224/21) and were registered in the German Clinical Trials Registry as DRKS00009277and DRKS00016157 (BASE-II and GendAge).

Consent to publish

Not applicable.

Availability of data and materials

Due to concerns for participant privacy, data are available only upon reasonable request. Please contact Ludmila Müller, scientific coordinator, at lmueller@mpib-berlin.mpg.de, for additional information.

Competing interests

The authors declare that they have no competing interests.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.jnha.2024.100206.

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