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Unintentional weight loss: Most risk factors do not differ between individuals with a healthy weight and those with overweight or obesity

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ABSTRACT

Objectives: Unintentional weight loss (UWL) is an important clinical indicator of malnutrition risk. Risk factors for UWL may differ by body size, measured by body mass index (BMI), and identifying at-risk individuals can be challenging in those with overweight/obesity.
Methods: Data from ~125 000 adults (≥18 y) in the Dutch Lifelines cohort were analyzed to examine whether associations between 21 potential risk factors spanning sociodemographic, psychological stress, disease, dietary, and quality-of-life domains and UWL differ by BMI group. Participants were classified as having a healthy weight (45.8%) or overweight/obesity (54.2%). Multivariable Poisson regression models estimated prevalence ratios for UWL, with sensitivity analyses to test robustness. Statistical significance was set at $P < 0.05$.
Results: UWL was reported by 4.9% of participants with a healthy weight and 2.7% of those with overweight/obesity. Positive associations with UWL were observed for female sex, (healthy-weight group only), absence from work due to disease, psychological stress in the past year, chronic obstructive pulmonary disease, depression, and poor quality-of-life indicators (physical functioning, perceived health, emotional well-being, vitality, and social functioning). Effect modification by BMI was suggested for 10 risk factors ($P < 0.1$), with associations generally more pronounced in the healthy-weight group. After sensitivity analyses, only higher educational attainment, psychological stress in the past year, and poor physical functioning retained significant modification.
Conclusions: Most risk factors for UWL were consistent between BMI groups. Differences in higher educational attainment, psychological stress in the past year, and physical functioning suggest that although the factors are similar, their impact may differ by BMI.

Introduction

Protein-energy malnutrition (PEM) is often under-recognized in individuals with overweight/obesity, despite it being the most common form of disease-related malnutrition [1]. With the rising prevalence of overweight and obesity, the phenotype of those at risk for PEM is also changing, highlighting the importance of recognizing this population [1]. PEM occurs when energy and protein/nutrient intakes are insufficient to meet requirements, or when disease-related processes such as inflammation, infection, or metabolic stress increase these requirements [2–4]. It is associated with altered body composition, impaired physical and cognitive function, and adverse clinical outcomes [2–4]. Although often identified in populations with low body weight, PEM can also occur in individuals with a higher body mass index (BMI), where excess body fat may mask signs of nutritional status deterioration or tissue wasting [1,5]. As a result, identifying PEM between different BMI groups, e.g., healthy weight vs. overweight/obesity, remains complex and requires further investigation.

Since risk factors are commonly used in screening tools to identify individuals at risk of malnutrition [6,7], it is crucial to determine whether these risk factors apply equally to individuals with a healthy weight and those with overweight/obesity. Unintentional

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weight loss (UWL) is an important predictor of malnutrition risk, even in patients who are not underweight according to BMI [8]. Therefore, UWL is considered a primary phenotypic criterion for identifying malnutrition, also in populations with overweight/obesity. UWL is influenced by various factors, including sociodemographic characteristics, psychological stress, disease status, dietary intake and specific aspects of quality of life [9]. These factors are often assumed to be relevant across all BMI groups, but this assumption remains unproven.

Underlying differences in weight loss mechanisms may lead to distinct risk profiles [10]. For example, mobility limitations and lifestyle or psychosocial factors may influence UWL differently depending on BMI. In healthy-weight individuals, mobility limitations often result from acute injury or illness, whereas in those with overweight/obesity, they may arise from chronic conditions, reduced stamina, or the physical strain of excess body weight [11–13]. Similarly, psychological stress can affect dietary intake differently, triggering emotional eating in individuals with overweight/obesity, but suppressing appetite in those with a healthy weight [9,14–15]. One's educational attainment may further modify the relationship between UWL and malnutrition risk by influencing dietary choices, health literacy, and access to healthcare [16].

Despite risk factors for UWL being well-documented in individuals with a healthy weight, their applicability to those with overweight/obesity remains unclear. This study examined whether associations between 21 potential risk factors across sociodemographic, psychological stress, disease, dietary, and quality-of-life domains and UWL differ by BMI group (i.e., healthy weight and overweight/obesity).

Methods

Data source

This study used data from Lifelines, a multidisciplinary, prospective, population-based cohort study that examines the health and health-related behaviors of 167 729 participants aged 0 to 93 y in the north of the Netherlands. The Lifelines study follows a unique three-generation design. It applies various investigative procedures to assess biomedical, sociodemographic, behavioral, physical, and psychological factors contributing to health and disease, with an emphasis on multimorbidity and complex genetics.

Participants were recruited between 2006 and 2013 through general practitioners (GPs), family members, and self-registration. Although no specific inclusion criteria were applied, individuals were excluded if they had a terminal illness (life expectancy <5 y), severe mental illness that impaired rational decision-making, were unable to visit a GP or complete the questionnaire, or were unable to speak or understand the Dutch language [17].

Inclusion criteria

Participants were eligible for this study if they were aged 18 y or older and had available data on BMI, UWL and relevant risk factors. The risk factors of interest in this study spanned five domains: 1) sociodemographic characteristics (age, sex, educational attainment, employment status); 2) perceived psychological stress level over the past year, assessed using a single 10-point scale question; 3) disease status; 4) diet quality, measured via the Lifelines Diet Score (LLDS) based on a 110-item food frequency questionnaire and stratified into quintiles; and 5) quality-of-life indicators, assessed with the RAND-36 Health Survey [18], including domains of physical functioning, general health perception, emotional well-being, vitality, pain, and social functioning.

Anthropometric measurements

Anthropometric measurements were taken during a physical examination conducted by a trained research nurse at a research facility. Weight (kg) was measured using a SECA 761 scale (without shoes and heavy clothing), and height (m) was assessed with a SECA222 stadiometer (without shoes), recorded to one decimal place for precision.

BMI was calculated from weight (kg) divided by squared height (m^2) and categorized using age-specific thresholds. Healthy weight was defined as 18.5–25 kg/m^2 for participants <65 y, 20–25 kg/m^2 for those aged 65–70 y, and 22–27 kg/m^2 for those >70 y [19]. Participants with BMI below the lower thresholds of the healthy weight category were categorized as underweight, while those above the upper thresholds were categorized as having overweight/obesity. The underweight group was excluded from the analyses, as the study focused on comparing risk factors for UWL between individuals with a healthy weight and those with overweight/obesity.

Self-administered questionnaires

Data were collected using self-administered questionnaires completed at home.

Unintentional weight loss (UWL)

UWL was assessed using self-reported questionnaire data, where participants were asked: "Have you lost a lot of weight recently without wanting to (6 kg in 6 mo or 3 kg in 1 mo)?" Responses were recorded as yes/no.

Sociodemographic characteristics, psychological stress level and disease status

Participants reported their age (in years), sex (male/female), educational attainment (low, middle, or high), and employment status (employed/unemployed). Educational attainment was classified as *low* (no, primary, or lower secondary education), *middle* (secondary vocational or senior general secondary education), and *high* (higher vocational or university education). Perceived psychological stress over the past year was assessed using a single-item 10-point scale, with higher scores indicating greater stress [17].

Disease status was also assessed through the self-administered questionnaires, in which participants reported whether they had ever been diagnosed with specific diseases and/or (undiagnosed) symptoms, including but not limited to cardiovascular disease, diabetes, respiratory disease, and musculoskeletal disorders. A full list of conditions is available through the Lifelines research portal [20].

Diet quality

Diet quality was assessed using the Lifelines Diet Score (LLDS), derived from a 110-item food frequency questionnaire (FFQ) [21]. The FFQ items were categorized into 22 food groups, which were classified as having positive, negative, neutral or unknown effects on health according to the evidence provided by Dutch food-based dietary guidelines [21,22].

Nine food groups: vegetables, fruit, whole grain products, legumes and nuts, fish, oils and soft margarines, unsweetened dairy, coffee and tea were linked to positive health effects. Three

food groups: red and processed meat, butter and hard margarines and sugar-sweetened beverages were associated with negative effects. Eggs were considered neutral. For nine others, the evidence was weak or absent, leaving their health effect unknown. These included potatoes, refined grain products, white unprocessed meat, cheese, savory & ready products, sugary products, soups, sweetened dairy and artificially sweetened products [21].

The nine positive and three negative food groups were combined to calculate the LLDS. To ensure that the LLDS reflected relative diet quality while accounting for differences in energy intake between individuals, food intake was expressed in grams per 1000 kilocalories (kcal) rather than in grams per day.

Intake for each food group was divided into quintiles to compare individual consumption within the study population. Each quintile was scored on a scale from 0 to 4. For positive food groups, the highest quintile received 4 points, while the lowest quintile for negative food groups received 0 points. The total LLDS score was obtained by summing the 12 component scores, resulting in a range from 0 to 48 [21].

Quality of life

Quality of life was assessed using the validated RAND-36 Health Survey [18], which measures eight domains of health-related quality of life: physical functioning, role limitations due to physical health problems, role limitations due to emotional problems, social functioning, pain, emotional well-being, energy/fatigue (vitality), and general health perceptions. Scores were transformed to a 0 to 100 scale, with higher scores indicating better health. In our study, the domains *role limitations due to physical problems* and *role limitations due to emotional problems* were excluded due to conceptual overlap with physical functioning and emotional well-being. Detailed descriptions of the RAND-36 items, response formats, and scoring procedures are provided in Supplementary Material. The RAND-36 also includes a single item assessing perceived change in health over the past year, which is often reported and analyzed separately.

Statistical methods

Descriptive statistics, stratified by BMI group (healthy weight vs. overweight/obesity), were used to summarize participant characteristics.

Poisson regression with robust standard errors was used to examine the association between potential risk factors (independent variables) and UWL (dependent variable), expressed as prevalence ratios (PRs). The assessed risk factors included sociodemographic characteristics: age (continuous), sex (dichotomous), educational attainment (categorical: low, middle, high), and employment status (dichotomous). Perceived psychological stress level over the past year was measured using a single-item 10-point scale. Disease status was assessed via self-reported diagnoses across 48 conditions [20]; for analysis, the eight most prevalent conditions in the cohort were highlighted to examine their associations with UWL. Diet quality was assessed via the LLDS score, derived from a 110-item FFQ, with intakes stratified into quintiles. Quality-of-life domains were measured using the RAND-36 Health Survey.

To examine whether associations with UWL differed by BMI group (healthy weight vs. overweight/obesity, interaction terms between each risk factor and BMI group were tested. Where evidence of effect modification was found, additional stratified analyses by BMI group were performed and adjusted for potential confounders (sex, age, and educational attainment), as appropriate. A *P*-value of 0.1 was used to assess effect modification, while significance levels were set at 0.05 for all other analyses. All analyses were performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA) [23].

Sensitivity analyses

A previous study based on Lifelines data found that individuals who expressed a desire to lose weight were 60% less likely to report experiencing UWL [24]. Since there is no plausible biological mechanism to explain a lower prevalence of UWL in this group, UWL was likely misclassified. Such misclassification could lead to an underestimation of effect sizes, biasing them towards the null (i.e., closer to 1 for prevalence rates) [25]. Notably, the desire to lose weight is more prevalent among individuals with overweight/obesity (70% in Lifelines) than among those with a healthy weight (30% in Lifelines). As a result, the misclassification of UWL is expected to be more pronounced in the overweight/obesity group, potentially introducing greater bias in this group compared to those with a healthy weight. This could create the appearance of effect modification where none truly exists. Therefore, we performed sensitivity analyses focusing on individuals who indicated that they had no desire to lose weight (as it is assumed that misclassification on UWL is less prevalent in that group) to assess if effect modification was mediated by potential misclassification on UWL.

Results

The study included 124 817 participants. Among these, 45.8% had a healthy weight, and 54.2% had overweight/obesity. The mean age was 44.8 y (SD: 13.0), and 58.8% were female. Among individuals with a healthy weight, 4.9% reported UWL, compared with 3.7% of those with overweight/obesity ($P < 0.001$). Most participants attained a middle-level education (40.0%), and the majority (79.2%) were employed. The cohort was primarily healthy, with 71% reporting no chronic diseases. Among participants with at least one chronic condition, depression was the most common (8.6%) (Table 1).

Effect modification by BMI group was observed for 10 of the 21 examined risk factors ($P < 0.1$; Fig. 1), including female sex, employment, psychological stress in the past year, COPD, depression, poor physical functioning, perceived health, emotional well-being, vitality, and social functioning. In nearly all cases, PRs were more extreme (further from 1) in the healthy weight group, indicating more pronounced associations with UWL. An exception was observed for females: in the healthy-weight group, they were more likely to report UWL than males (PR = 1.13, [95% CI: 1.05−1.23]), whereas in the overweight/obesity group, females were less likely to report UWL than males (PR = 0.84, [95% CI: 0.76−0.93]; $P < 0.001$ for interaction).

Within the selected domains of sociodemographic characteristics, disease status, and quality-of-life factors (Fig. 1), the more pronounced associations were for absence from work due to disease (healthy weight: PR = 3.02, [95% CI: 2.70−3.39]; overweight/obesity: PR = 3.05, [95% CI: 2.66−3.49]), diabetes (healthy weight: PR = 2.41, [95% CI: 1.90−3.07]; overweight/obesity: PR = 1.91, [95% CI: 1.58−2.31]), and poor social functioning (healthy weight: PR = 2.28, [95% CI: 2.11−2.46]; overweight/obesity: PR = 2.02, [95% CI: 1.84−2.23]).

In the sensitivity analyses, we restricted the sample to participants who reported no desire to lose weight, to minimize potential misclassification of UWL (Fig. 2). Of the 21 examined risk factors, only three showed significant effect modification between the two

Table 1
Characteristics of adults aged ≥18 y in the Lifelines cohort, stratified by BMI Group and prevalence of unintentional weight loss

	Healthy weight (n = 57 167, 45.8%)		**Overweight/obesity** (n = 67 650, 54.2%)		**Total** 124 817
	No unintentional weight loss (n = 54 349, 95.1%)	Unintentional weight loss (n = 2818, 4.9%)	No unintentional weight loss (n = 65 858, 97.3%)	Unintentional weight loss (n = 1792, 2.7%)	
Age (years)	42.5 (±13.5)	40.4 (±13.7)	46.9 (±12.1)	45.3 (±12.2)	44.8 (±13.0)
18–40	23 953 (44.1%)	1466 (52.0%)	19 223 (29.2%)	594 (33.1%)	45 236 (36.2%)
40–65	27 315 (50.3%)	1216 (43.2%)	41 955 (63.7%)	1094 (61.0%)	71 580 (57.3%)
65–80	3081 (5.7%)	136 (4.8%)	4680 (7.1%)	104 (5.8%)	8001 (6.4%)
BMI	22.8 (±1.6)	22.2 (±1.7)	29.0 (±3.6)	28.9 (±3.6)	26.1 (±4.3)
Sex					
Male	19 001 (35.0%)	919 (32.6%)	30 542 (46.4%)	913 (50.9%)	51 375 (41.2%)
Female	35 348 (65.0%)	1899 (67.4%)	35 316 (53.6%)	879 (49.1%)	73 442 (58.8%)
Educational attainment					
Low	12 265 (22.8%)	851 (30.5%)	22 180 (34.1%)	727 (41.1%)	36 023 (29.2%)
Middle	21 494 (40.0%)	1120 (40.1%)	25 996 (40.0%)	683 (38.6%)	49 293 (40.0%)
High	20 025 (37.2%)	819 (29.4%)	16 820 (25.9%)	361 (20.4%)	38 025 (30.8%)
Employment					
Employed	44 190 (81.5%)	2130 (75.9%)	50 994 (77.7%)	1312 (73.6%)	98 626 (79.2%)
Unemployed	10 017 (18.5%)	677 (24.1%)	14 669 (22.3%)	471 (26.4%)	25 834 (20.8%)
Absence from work due to disease					
No absence	29 822 (54.9%)	1168 (41.4%)	32 943 (50.0%)	670 (37.4%)	64 603 (51.8%)
Absence	2754 (5.1%)	368 (13.1%)	4607 (7.0%)	304 (17.0%)	8033 (6.4%)
Missing	21 773 (40.1%)	1282 (45.5%)	28 308 (43.0%)	818 (45.6%)	52 181 (41.8%)
Psychological stress in the past year					
No	25 071 (46.5%)	774 (27.9%)	27 604 (42.4%)	493 (28.0%)	53 942 (43.6%)
Yes	28 820 (53.5%)	2000 (72.1%)	37 569 (57.6%)	1268 (72.0%)	69 657 (56.4%)
Disease status					
Chronic fatigue syndrome	629 (1.2%)	85 (3.0%)	839 (1.3%)	49 (2.7%)	1602 (1.3%)
Arthritis	898 (1.7%)	70 (2.5%)	1595 (2.4%)	71 (4.0%)	2634 (2.1%)
Burnout	4141 (7.6%)	332 (11.8%)	5906 (9.0%)	229 (12.8%)	10 608 (8.5%)
Cancer	2377 (4.4%)	165 (5.9%)	3211 (4.9%)	116 (6.5%)	5869 (4.7%)
Chronic obstructive pulmonary disease (COPD)	2156 (4.0%)	218 (7.8%)	4043 (6.1%)	177 (9.9%)	6594 (5.3%)
Depression	4701 (8.6%)	473 (16.8%)	6566 (10.0%)	300 (16.7%)	12 040 (9.6%)
Diabetes	540 (1.0%)	67 (2.4%)	2384 (3.6%)	120 (6.7%)	3111 (2.5%)
Heart attack	293 (0.5%)	20 (0.7%)	946 (1.4%)	44 (2.5%)	1303 (1.0%)
Diet quality					
Q1	9915 (18.4%)	676 (24.4%)	11 668 (18.0%)	438 (24.8%)	22 697 (18.4%)
Q2	11 680 (21.7%)	642 (23.2%)	14 808 (22.8%)	426 (24.2%)	27 556 (22.3%)
Q3	9951 (18.5%)	492 (17.8%)	12 685 (19.5%)	321 (18.2%)	23 449 (19.0%)
Q4	11 442 (21.2%)	497 (18.0%)	14 055 (21.6%)	317 (18.0%)	26 311 (21.3%)
Q5	10 917 (20.3%)	458 (16.6%)	11 724 (18.1%)	261 (14.8%)	23 360 (18.9%)
RAND-36 survey Physical functioning					
Below median	27 942 (51.7%)	1070 (38.3%)	22 323 (34.2%)	504 (28.5%)	51 839 (41.9%)
Above median	26 070 (48.3%)	1725 (61.7%)	42 926 (65.8%)	1265 (71.5%)	71 986 (58.1%)
General health perception					
Below median	31 615 (58.3%)	1157 (41.2%)	31 777 (48.4%)	635 (35.5%)	65 184 (52.4%)
Above median	22 601 (41.7%)	1653 (58.8%)	33 920 (51.6%)	1153 (64.5%)	59 327 (47.6%)
Emotional well-being					
Below median	26 329 (48.6%)	1869 (66.6%)	30 320 (46.2%)	1065 (59.7%)	59 583 (47.9%)
Above median	27 849 (51.4%)	939 (33.4%)	35 287 (53.8%)	719 (40.3%)	64 794 (52.1%)
Vitality					
Below median	28 758 (52.9%)	2000 (71.0%)	36 643 (56.0%)	1237 (69.6%)	68 638 (55.3 %)
Above median	25 355 (46.9%)	796 (28.2%)	28 842 (44.0%)	540 (30.4%)	55 533 (44.7%)
Pain					
Below median	22 571 (41.6%)	1408 (50.1%)	30 104 (45.8%)	944 (52.9%)	55 027 (44.1%)
Above median	31 667 (58.4%)	1402 (49.9%)	35 595 (54.2%)	840 (47.1%)	69 504 (55.8%)
Social functioning					
Below median	22 985 (42.7%)	1791 (64.5%)	29 037 (44.7%)	1093 (62.3%)	54 906 (44.5%)
Above median	30 805 (57.3%)	984 (35.5%)	35 943 (55.3%)	662 (37.7%)	68 394 (55.5%)

Diet quality: Q1–Q5 denote quintiles of the Lifelines Diet Score (LLDS), with Q1 indicating the lowest dietary quality and Q5 the highest
Values are presented as counts with corresponding percentages of the total population

BMI groups (healthy weight vs. overweight/obesity): educational attainment (middle: P = 0.006; high: P = 0.003), psychological stress in the past year (P = 0.017), and poor physical functioning (P = 0.011).

For educational attainment, both middle and high levels were associated with a lower likelihood of UWL in both BMI groups, with more pronounced associations among individuals with a healthy weight (middle: PR = 0.75, [95% CI: 0.66–0.80]; high: PR = 0.63, [95% CI: 0.56–0.70]) compared to those with overweight/obesity (middle: PR = 0.95, [95% CI: 0.79–1.14]; high: PR = 0.88, [95% CI: 0.71–1.11]).

A similar pattern was observed for psychological stress in the past year and poor physical functioning: both were associated with an increased likelihood of UWL in both BMI groups, but with

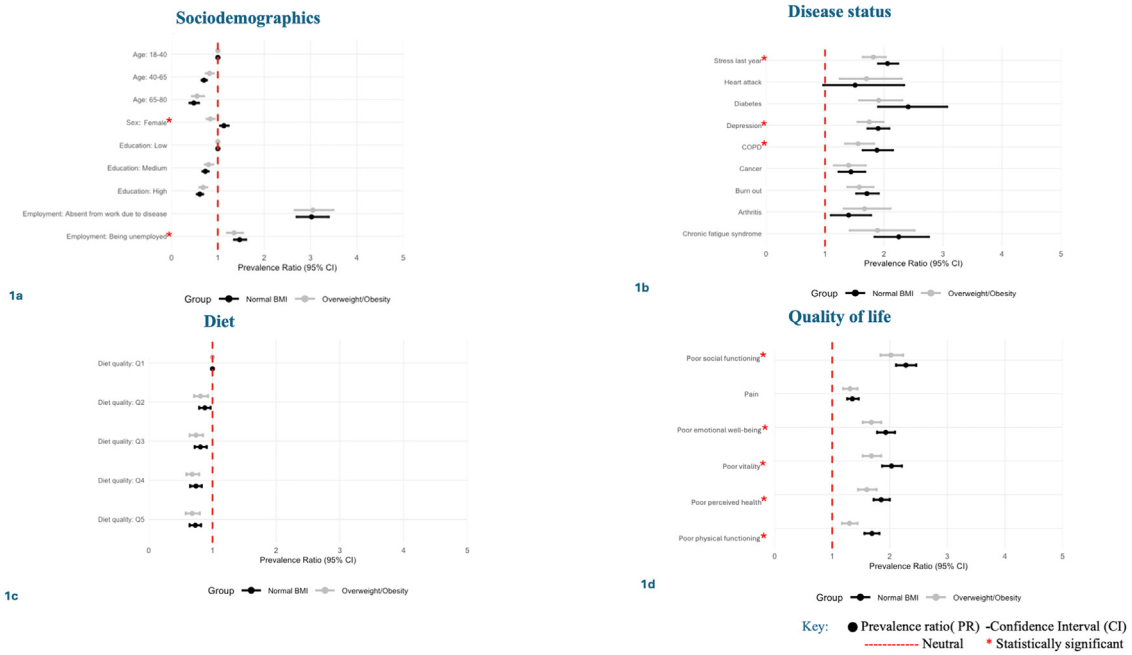

Fig. 1. Multivariate analyses of multiple risk factors for unintentional weight loss in the Lifelines cohort, stratified by BMI.

more pronounced associations in the healthy weight group than in the overweight/obesity group (psychological stress in the past year: PR = 2.05, [95% CI: 1.88–2.25] vs. 1.66, [95% CI: 1.40–1.97]; poor physical functioning: PR = 1.76, [95% CI: 1.62–1.91] vs. 1.44, [95% CI: 1.20–1.71]).

Several risk factors that had appeared as effect modifiers in the primary analysis, such as COPD and depression (Fig. 1), did not show significant effect modification in the sensitivity analyses. Despite this, associations with UWL persisted in both BMI groups, and the effect sizes in the overweight/obesity group became more similar to those observed in the healthy weight group. Retesting for effect modification confirmed that, apart from higher educational attainment, psychological stress in the past year, and poor physical functioning, the observed differences in the primary analyses largely reflected variation in magnitude rather than direction of the associations.

Detailed values from these analyses are provided in Tables S1 and S2 of the supplementary information.

Discussion

This study examined 21 potential risk factors for UWL in the Lifelines cohort, a large prospective population-based study including mostly Dutch, Caucasian participants of all ages [17]. Although based in the northern Netherlands, the cohort is broadly representative of the Dutch population in terms of age,

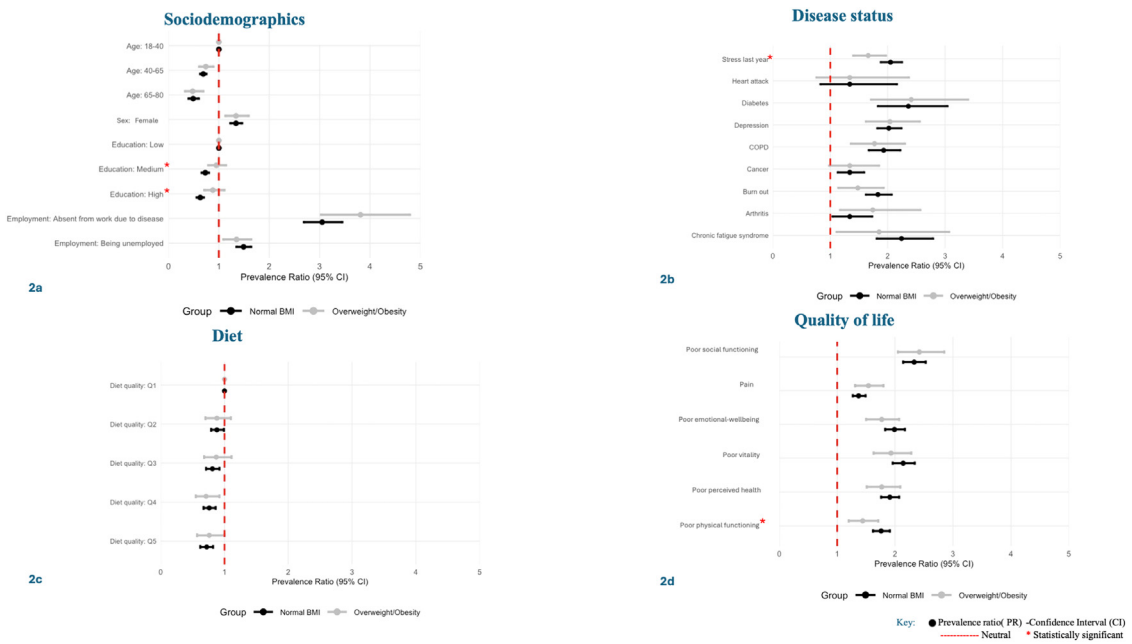

Fig. 2. Sensitivity analyses of multiple risk factors for unintentional weight loss in the Lifelines cohort, stratified by BMI.

sex, socioeconomic status, and health characteristics. Therefore, the findings are likely to be generalizable to the national population. However, caution should be exercised when applying them to populations with different demographic or cultural backgrounds.

For our analysis, we included adults (≥18 y) and compared two BMI groups: healthy weight and overweight/obesity. UWL was positively associated with sociodemographic factors (female sex, only in the healthy-weight group, and absence from work due to disease), diseases (diabetes, COPD, and depression), and poor quality-of-life indicators (physical functioning, perceived health, emotional well-being, vitality, and social functioning). Effect modification by BMI was observed for 10 risk factors, including female sex, employment, psychological stress in the past year, COPD, depression, poor physical functioning, perceived health, emotional well-being, vitality, and social functioning, indicating that the strength of the associations with UWL differed between BMI groups, with most risk factors showing more pronounced associations in the healthy weight group. Following sensitivity analyses to account for potential misclassification of UWL, only three risk factors (higher educational attainment, psychological stress in the past year, and poor physical functioning) retained significant effect modification by BMI group. These findings suggests that while most UWL risk factors are largely similar between BMI groups, their relative strength and underlying mechanisms may differ.

Higher educational attainment, at both middle and high levels, was associated with a lower risk of UWL in both BMI groups, with the protective effect appearing more pronounced in individuals with a healthy weight than in those with overweight/obesity. Education may promote health literacy, self-monitoring and earlier engagement with healthcare, enabling prompt recognition and response to emerging health concerns [16]. However, among individuals with overweight/obesity, these protective effects may be attenuated, particularly if education does not translate into health-specific knowledge or if systemic barriers delay care-seeking despite increased health risk [26]. Furthermore, individuals with overweight/obesity may be more inclined to perceive a certain degree of weight loss as acceptable or desirable, even when unintentional, which could reduce the likelihood of recognizing or reporting UWL as a potential health concern [24].

Psychological stress in the past year was associated with UWL in both BMI groups, with the association slightly more pronounced among individuals with a healthy weight. While this difference reached statistical significance, the absolute magnitude was modest, and its clinical relevance is likely limited. The underlying mechanisms linking psychological stress and UWL may vary between individuals, but small differences between BMI groups should be interpreted cautiously [14–15,27].

Similarly, poor physical functioning differed in its association with UWL by BMI group. Among individuals with a healthy weight, poor physical functioning may reflect more severe or acute conditions, such as illness or injury, directly causing weight loss through metabolic strain or reduced dietary intake [11]. Conversely, among those individuals with overweight/obesity, certain problems may often stem from excess body weight itself, leading to reduced mobility and stamina, as captured by the RAND-36 [12,13,18], without necessarily resulting in UWL or malnutrition. Additionally, behavioral responses such as reduced physical activity due to fatigue or pain, or increased food intake in response to stress, as previously discussed, may further mask or offset weight loss in the overweight group.

Overall, our findings suggest that although risk factors for UWL are largely shared between BMI groups, their underlying mechanisms and clinical relevance may differ. This has important implications for malnutrition risk screening. Traditional malnutrition screening tools focus on indicators such as low BMI, low muscle mass, and recent weight loss [19]. However, there is increasing interest in identifying individuals at risk of future malnutrition or showing early subclinical signs of decline (malnutrition in progress) [7].

In this context, our results indicate that many risk factors for UWL apply to both the BMI groups of healthy weight and overweight/obesity when assessing malnutrition risk. Nevertheless, interpretation should be tailored to an individual's body size (measured by BMI), as indicators like low BMI may be misleading in those with higher BMI. In such cases, UWL becomes a key marker of nutritional risk. Thus, while the core risk factors remain relevant, screening tools should consider BMI when interpreting responses, since the same risk factors may manifest differently or carry a different clinical impact in individuals with obesity. This approach may improve early recognition and care in these individuals, often under-recognized by existing tools.

Sensitivity analyses helped reveal the true nature of associations by filtering out noise introduced by incorrect classification of intentional vs. unintentional weight loss. However, in routine clinical practice, it is often not feasible to conduct such detailed adjustments. Therefore, screening for UWL should first establish whether weight loss is intentional or unintentional, as misclassification can lead to underestimation of risk and may cause clinicians to overlook individuals who are truly at risk for malnutrition [24].

Some limitations were present in this study. First, individuals with overweight/obesity were grouped into a single BMI group to ensure sufficient statistical power, particularly for sensitivity analyses. This approach may have obscured distinctions between overweight and obesity and reduced specificity. Second, although we conducted sensitivity analyses to address potential recall bias [6], all medical information, including disease status and UWL, was self-reported, which could have introduced misclassification or inaccuracies. Distinguishing intentional from unintentional weight loss remains particularly challenging and poses a greater threat to validity than measurement error alone, as it directly affects the interpretation of risk-outcome relationships. Third, the analysis was limited to baseline data and did not include follow-up, preventing assessment of temporal changes in weight or causal inferences. Additionally, objective measures such as laboratory tests or body composition data were not included, and unmeasured confounders (e.g., medication use, physical activity, other socioeconomic and lifestyle factors) could have influenced the observed associations. Finally, baseline data were collected more than 10 y ago. Since then, population-level patterns in education, health behaviors, and awareness of nutrition and physical activity may have shifted. These changes may influence the current distribution or magnitude of some risk factors. However, the underlying biological and psychosocial mechanisms linking psychological stress, disease burden, quality of life and UWL are unlikely to have fundamentally changed, making the observed associations still informative, although present-day effect sizes may differ. Replication studies using more recent data are therefore recommended.

Despite these limitations, the study has notable strengths. The large sample size provided high statistical power, and although sensitivity analyses were conducted on subsets, where power is typically smaller, and effect sizes can be reduced, the subsets in our study remained substantial. The consistency of effect sizes across analyses after sensitivity adjustments highlights the robustness and reliability of the observed associations.

Conclusion

The study findings reveal that most risk factors examined were positively associated with UWL in both BMI groups. After accounting for potential misclassification, only higher educational attainment, psychological stress in the past year, and poor physical functioning showed significant effect modification by BMI. For these factors, associations were generally more pronounced in individuals with a healthy weight than in those with overweight/obesity. The overall similarity in risk factors for both BMI groups supports the potential use of a common set of risk factors in malnutrition screening tools for both groups, while acknowledging that the relative impact of some factors may differ by body size, measured by BMI.

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Declaration of competing interest

The authors declare the following financial interests/personal relationships, which may be considered as potential competing interests: Marian A.E. de van der Schueren reports institutional financial support was provided by Netherlands Organisation for Health Research and Development. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Natasha Nalucha Mwala: Writing – original draft, Investigation, Data curation. **Jos W. Borkent:** Methodology, Formal analysis, Data curation, Conceptualization, Writing – review & editing, Supervision. **Barbara S. van der Meij:** Writing – review & editing, Supervision. **Marian A.E. de van der Schueren:** Writing – review & editing, Supervision.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.nut.2025.113079.

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