Time to tip the scales: tackling overweight and obesity in primary care

Hout, W.J. van den

Part I

Current practices

Chapter 2

Recording practices of body mass index, overweight and obesity by Dutch general practitioners: an observational study

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Abstract

Background

Routine body mass index (BMI) recording in electronic health records (EHR) could support general practitioners (GPs) in managing patients with obesity. This study aimed to evaluate recording practices of BMI, overweight, and obesity in adults including subgroup analysis of age, sex, and comorbidities in primary care in the Netherlands.

Methods

An observational study of individuals aged ≥ 18 years and registered between 2007 and 2023, using routine healthcare data from the Extramural LUMC Academic Network (ELAN) in the Netherlands. Outcomes were (i) incidence rates of a recorded BMIs per 1000 person-years for sex and ten-year age categories (ii) proportions of recorded BMIs for different comorbidities and (iii) proportions of diagnosis of overweight (BMI between 25 and 30 kg/m^2) and/or obesity (BMI ≥ 30 kg/m^2) for a corresponding recorded BMI.

Results

Approximately 30% of 676,708 individuals had a recorded BMI. Highest incidence rate (186 per 1000 person-years) was at age 71 to 80 years. At least one BMI was recorded in 68.5% of individuals with chronic obstructive pulmonary disease, 70.6% with hypertension, 86.3% with type II diabetes, 42.4% with eating disorders, 36% with depression and 64.2% with osteoarthritis. Diagnoses of overweight and/or obesity were found in 11.5% of individuals with a BMI between 25 and 30 kg/m^2 and in 36.4% with a BMI of ≥ 30 kg/m^2.

Conclusion

In the Netherlands, GPs recorded BMIs in nearly one third of all adults, mainly in adults with chronic diseases. Routinely recording BMI is not currently standard practice. With the increasing prevalence of obesity and its related comorbidities, it may be beneficial to start routinely recording BMI in primary care.

Introduction

Obesity is associated with a high risk of developing various diseases, including type II diabetes (DM2), cardiovascular disease, osteoarthritis and cancer, contributing to an increased morbidity and mortality in patients with obesity (1, 2). Early diagnosis of overweight and obesity in primary care might mitigate these negative effects and has been shown to be an important step towards weight loss (3, 4). Since general practitioners (GPs) often underestimate patients' weight when solely relying on visual assessment, an important first step might be to record an adequate body mass index (BMI) in the electronic health record (EHR) (5). This also yields benefits for the GPs as evidence shows that a recorded BMI in the EHR makes it easier for them to discuss weight (3, 6). Additionally, GPs find it useful to have a recorded BMI in the EHR when prescribing medications, writing referral letters, collaborating with colleagues (e.g., emergency services), and interpreting laboratory results (6).

Dutch GPs consultations are different from some other countries in that patients are not typically seen by a practice nurse for physical assessment beforehand. Additionally, the GP consultations only last 10–15 min and BMI is not routinely measured by the GP, unless it is relevant to the reason for consultation. Patients with comorbidities such as chronic obstructive pulmonary disease (COPD) and diabetes are however regularly (e.g., quarterly, or annually) seen by the practice nurse. The practice nurse is a specially trained healthcare professional who supports the GP in the management of chronic diseases and preventive care. In practice nurse consultations, it is expected that BMI is more frequently recorded in the EHR.

The aim of this study is to evaluate current recording practices of BMIs in primary care in the Netherlands, concerning age, sex, comorbidities, as well as recording practices concerning the diagnosis made of overweight (BMI between 25 and 30 kg/m^2) and obesity (BMI ≥30 kg/m^2) for a corresponding recorded BMI.

Methods

Study design and study population

This is an observational study from a population-based cohort in the Netherlands using routine healthcare data approached from the Extramural LUMC Academic Network (ELAN). ELAN is a regional integrative population-based data infrastructure in which medical, social, and public health data is linked at the patient level from the greater The Hague and Leiden area (7, 8). Individuals were included if they were registered between 1st of January 2007 and 30th of June 2023 at an ELAN-participating general

practice and were at least 18 years old or became 18 years old during the study period. Individuals with a follow-up duration in a general practice of less than a month were excluded, as these patients were likely registered for a very short period, such as vacationers, for whom routine recording BMI was generally irrelevant.

Data collection

Outcome

In this study we used height, weight and BMI that was coded during the study period (2007–2023) within the structured EHR as a laboratory result. The recorded BMIs were derived from an already available BMI (automatically calculated by the GPs information system), or BMI was calculated using a recorded height and weight on the same date or a recorded weight and a previous recorded height. All recorded BMIs were divided into a measurement of <25 kg/m^2 (normal weight), 25–30 kg/m^2 (overweight) and ≥30 kg/m^2 (obesity). For a diagnosis of overweight or obesity, we used the first recorded diagnosis of overweight (International Classification of Primary Care (ICPC) T83) or obesity (ICPC T82). A first recorded diagnosis prior to the study period (before 2007) was also included. The diagnoses are based on an episode and a thereto linked ICPC-code. An episode is defined as the context within which a diagnosis is established and managed, including all events and activities throughout the patients care pathway (9).

Covariates

Age, year of birth and sex were derived at cohort entry. Age was divided into seven age categories: 18–30, 31–40, 41–50, 51–60, 61–70, 71–80, and ≥ 81 years. Five diagnosed comorbidities were selected which are related to weight change, overweight or obesity (1, 10-13): COPD (ICPC R91-R91.01-R91.02-R95), hypertension (ICPC K85-K86-K87), DM2 (T90.02), eating disorders (ICPC T06-T06.01-T06.02), depression (ICPC P03-P76-P76.01-P76.02) and osteoarthritis (ICPC L89-L90-L91). These comorbidities were based on a registered episode and a thereto linked ICPC. For each comorbidity every first recorded diagnosis was included. A first recorded diagnosis prior to the study period (before 2007) was also included. Due to the non-chronic nature of depression and eating disorders, we also included a first recorded diagnosis during the study period (2007–2023) for these two diseases, to be able to additionally examine whether a BMI was recorded within one year before and after these diagnoses were made. In individuals with multiple diagnoses of depression or eating disorders during the study period only the first diagnosis was included.

Statistical analysis

Baseline characteristics of the study population were summarized median (25th, 75th percentiles) or as percentage. Follow-up time in person-years was calculated from cohort entry (at least 18 years and registered in a general practice from the 1st of January 2007) until deregistration with a participating general practice, death, or end of the study period (30th of June 2023).

First, we calculated the incidence rates of a recorded BMI within each year (from 2007 to 2023) per 1000 person-years. If multiple recorded BMIs for an individual were recorded within one year, only the first recorded BMI within that year was included. Individuals were censored after a first recorded BMI in that year. Second, using this same technique, we calculated the incidence rates of a recorded BMI in each age category per 1000 person-years, followed by a sub-analysis for men and women. Cox regression was used to examine differences in incidence rates between men and women across age categories and to examine differences in incidence rates among age categories (reference category 18–30 year), adjusted for the calendar year in which the BMI was recorded. We reported hazard ratios (HR) with 95% confidence intervals. Third, proportions were calculated of at least one recorded BMI for COPD, hypertension, DM2, eating disorders, depression and osteoarthritis. A sub-analysis was performed for eating disorders and depression, examining the proportions of BMI recordings within one year before or after these diagnoses were made. Fourth, proportions were calculated for a coded diagnosis of overweight and/or obesity based on a corresponding BMI. Overweight was defined as a BMI between 25 and 30 kg/m^2 and obesity as a BMI of 30 kg/m^2 or higher. The data was pre-processed using R Statistical Computing (version 4.3.1) and SPSS statistical software (version 29, IB Corporation, Armonk, NY). All statistical analyses were performed using SPSS statistical software.

Results

Characteristics of the study population

Our analysis included 676,708 individuals (Figure 1), with a total of 1,553,555 BMIs and 5,717,777 person-years. Baseline characteristics of this population are presented in Table 1. Almost 30% had at least one recorded BMI.

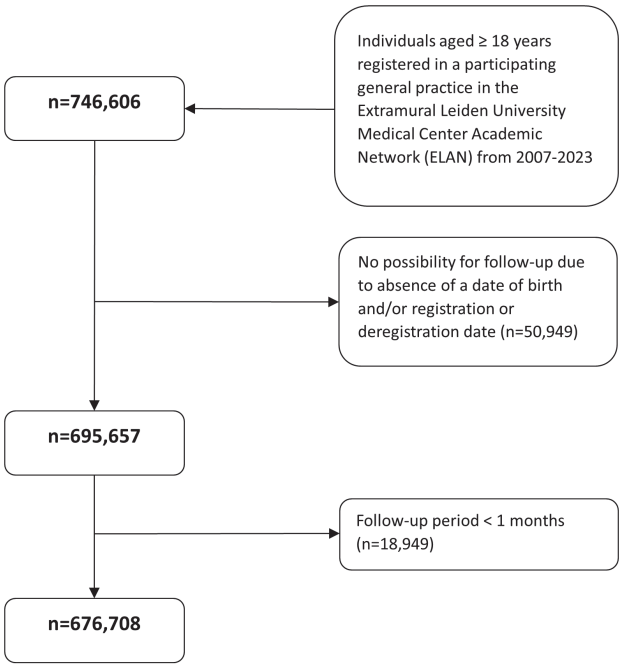

Figure 1 Flowchart with exclusion criteria

Table 1 Baseline characteristics routine healthcare cohort of ELAN, 2007-2023 from 18 years and older

	Total population n=676,708
Sex (% men)	48.0
Year of birth (year, median, IQR)	1971 (1954-1987)
Age at entry cohort (years, median, IQR)	40.0 (26.0 -56.0)
Follow-up in general practice (person-years, median, IQR)	7.5 (2.8 – 15.5)
Recorded BMI (%) - First recorded BMI <25kg/m^2 (%) - First recorded BMI 25-30kg/m^2 (%) - First recorded BMI ≥30kg/m^2 (%)	28.8 9.0 11.2 8.6
Overweight* (%)	3.4
Obesity* (%)	3.5
COPD* (%)	3.6
Hypertension* (%)	20.4
Type II diabetes* (%)	7.3
Eating disorders* (%)	0.3
Depression* (%)	11.9
Osteoarthritis* (%)	9.8

IQR: interquartile range, BMI: body mass index.
*Based on the international classification of primary care (ICPC) codes

Recorded BMIs from 2007 to 2023

The incidence rates of at least one recorded BMI increased with 61 to 215 per 1000 person-years from 2007 to 2019. During the COVID-19 pandemic (2020, 2021, 2022), the incidence rates decreased to 173, 200 and 203 per 1000 person-years respectively. The highest incidence rate was observed in 2023 with an incidence rate of 263 person-years (Figure 2).

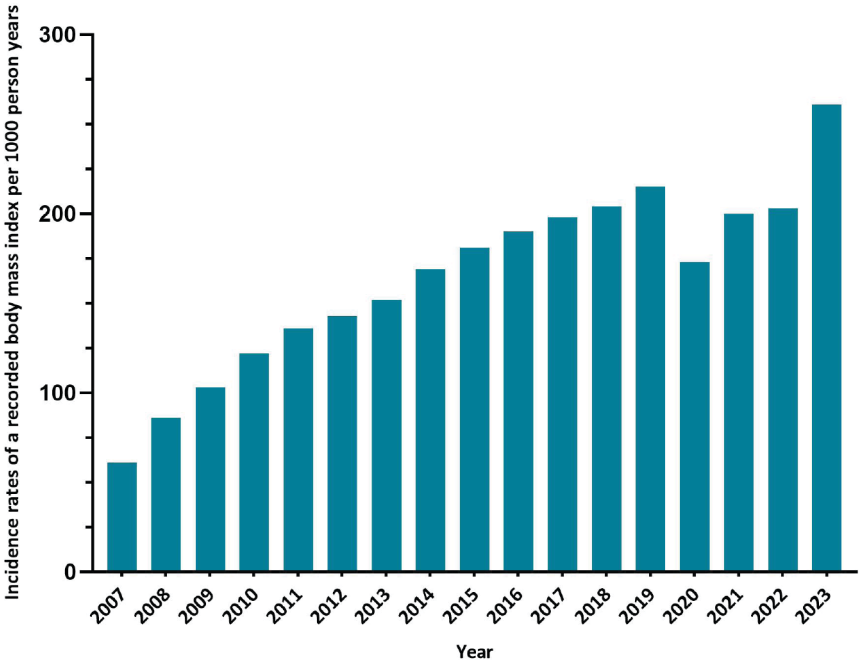

Figure 2 Incidence rates of a recorded body mass index per year 2007–2023

Recorded BMIs per age category and sex

The incidence rate of a recorded BMI per 1000 person-years was highest in the age category 71–80 years (186 per 1000 person-years; HR: 10.38; 95% CI 10.20-10.57) compared with the age category 18–30 years old. In the oldest age category (≥ 81 years), the incidence rate decreased to 154 per 1000 person-years (HR: 8.86 95% CI: 8.69–9.04). Adjusting for the calendar year in which the BMI was recorded, the hazard ratio (reference category 18–30 year), continued to increase, even in the oldest age category (Supplemental table 1).

At younger ages, a recorded BMI was more frequent in women than in men (age category 18–30 years: HR 1.63; 95% CI 1.58–1.68). This equalled for men and women in the age category 51–60 years (HR 1.01; 95% CI 0.99– 1.02). In the age categories above 60, recorded BMIs were always more frequent in men than in women. The largest difference was found in the oldest age category (≥ 81 years) with an incidence rate of a recorded BMI of 174 for men and 142 for women per 1000 person-years (HR 0.86; 95% CI 0.84–0.88) (Figure 3).

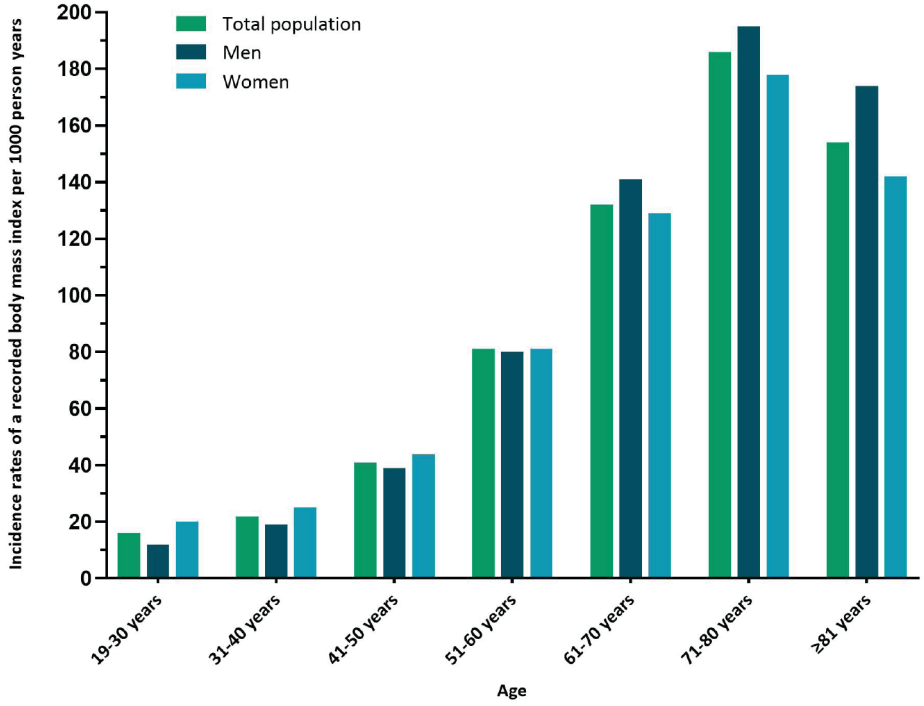

Figure 3 Incidence rates of a recorded body mass index per 1000 person years within age categories (n = 676,708)

Diagnosis of overweight and/or obesity

In 15.0% (n = 101,517) of the study population, a BMI between 25 and 30 kg/m^2 was recorded. Of these individuals, 11.5% showed a coded diagnosis of overweight and/or obesity. In 10.7% (n = 72,280) of the study population, a BMI of more than 30 kg/m^2 was recorded. Of these individuals, 36.4% showed a coded diagnosis of overweight and/or obesity (Figure 4).

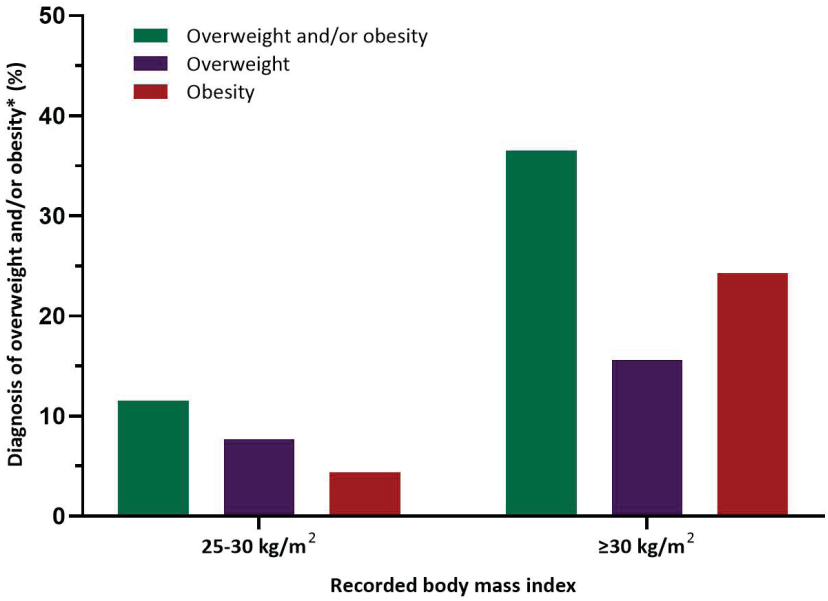

Figure 4 Diagnosis of overweight and/or obesity* within a recorded body mass index
*based on the International Classification of Primary Care (ICPC) codes
Recorded body mass index between 25-30 kg/m^2 n=101,517, recorded body mass index ≥30 kg/m^2 n=72,280

Recorded BMIs per comorbidity

Proportions of at least one recorded BMI were 68.5% in individuals with COPD, 70.6% for hypertension, 86.3% for DM2 and 64.2% for osteoarthritis. For eating disorders and depression, the proportions were 42.4% and 36% respectively (Figure 5). In the sub-analyses in which we included only individuals with an eating disorder (n = 957) or depression (n = 46,973) between 2007 and 2023 and a recorded BMI before and after the year of the coded diagnosis, the proportions were 20.3% and 29.5% respectively.

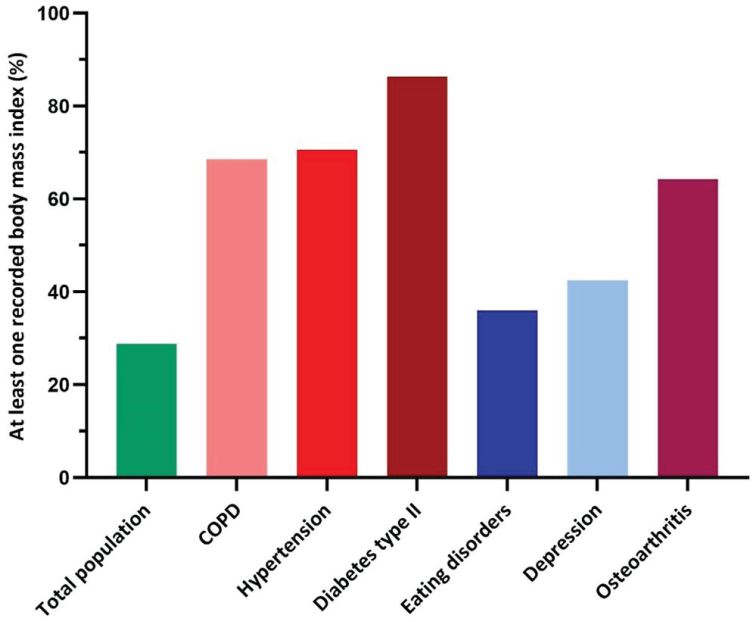

Figure 5 At least one recorded body mass index in patients with different co-morbidities*. COPD: chronic obstructive pulmonary disease, *based on the International Classification of Primary Care (ICPC) codes. Total population n = 676,708, COPD n = 24,150, hypertension n = 137,776, diabetes type II n = 49,652, eating disorders n = 2,172, depression n = 80,531, osteoarthritis n = 66,531

Discussion

In this observational study of 676,708 individuals using routine healthcare data from a Dutch cohort, almost 30% of the individuals had a recorded BMI in primary care. Incidence rates have been increasing consistently from 2007 to 2023 (except during the COVID-19 pandemic). The incidence rate of a recorded BMI per 1000 person-years increased with age, with the highest incidence rate in the age category of 71 to 80 years old. At younger age, more women than men had a recorded BMI while at older age more men than women. GPs recorded BMIs more often in individuals on indication, mainly in chronic diseases like COPD, hypertension, DM2 and osteoarthritis. In psychiatric disorders (depression and eating disorders) affecting weight changes, BMI was frequently recorded. A coded diagnosis of overweight (25-30 kg/m^2) or obesity (≥30 kg/m^2) was recorded in only a small fraction of those who had a BMI recording indicative for these conditions.

The increase in recorded BMIs over the years was also observed in previous studies (14, 15). In this study, a notable decrease in BMI recordings occurred in the years 2020 to 2022. This decrease can be explained by the COVID-outbreak during these years and

the restrictions taken at that time resulting in fewer visits to the GP and practice nurse (16-18). A positive development is that BMI recordings increased again in 2023. These findings suggest a growing awareness of the importance of recording BMI in the EHR in primary care but also show the value of in practice encounters. It is remarkable that the proportion of a recorded BMI in the Netherlands is considerably lower compared with data from other countries such as the United States, the United Kingdom and Australia (14, 19-21). In the Netherlands, according to the guidelines, recording BMI is standard practice for specific comorbidities such as COPD and DM2, as well as during cardiovascular risk assessment (22-24). However, it is not standard practice for the general population, whereas in some other countries, recording BMI might be standard practice for all patients visiting the general practice. Besides, comparing the studies from the different countries is difficult due to methodological differences, such as variability in follow-up duration and differences in inclusion criteria for patients with a minimal number of consultations with their GP. Our study included the entire population, including individuals who did not visit their GP. Interestingly, mortality rates for obesity-related diseases between the United Kingdom and the Netherlands are similar (25, 26), while proportions of recorded BMIs are different between these countries. Nonetheless, it remains unclear whether GPs are already more aware through routine recording BMI or if their awareness increases as a result of a recorded BMI. However, recording the BMI can change GPs behaviour, for example by making it easier to discuss weight during follow-up visits (3, 6). Further research should focus on factors influencing BMI recording practices within different healthcare systems across countries and the subsequent consequences of these practices.

Regarding the sex differences, more women than men had a recorded BMI at younger ages, while at older ages, more men than women had their BMI recorded. This might be related to the difference in consultation rates between men and women. About 80% of the women between the ages 16 and 54 years visit the GP at least once yearly, versus about 60% of men of the same age. At older ages, however, the consultation rates between men and women are nearly equal (27).

In line with previous studies, BMI is more often recorded in older patients with obesity-related comorbidities such as COPD, hypertension, and diabetes (19, 20, 28). This could be explained by these patients being routinely seen by the practice nurse due to the introduction of an integrated and structured care system since 2007 for patients with COPD, DM2 and cardiovascular risk management in the Netherlands (29-31). In this integrated care system, unlike in the United Kingdom where pay for performance exists (14, 32), there is no financial incentive for BMI recordings in the Netherlands (33).

It is noteworthy that individuals with eating disorders and depression less frequently have a recorded BMI than patients with COPD, hypertension, DM2 and osteoarthritis. This discrepancy could be explained by the higher prevalence of these psychiatric disorders among younger individuals, of whom a BMI is already less frequently recorded (Figure 3). Additionally, GPs might be more hesitant with these individuals, as measuring BMI can sometimes be very triggering. Certain psychiatric disorders are associated with obesity and weight change (12, 34-37), with depression for example sharing the same biological mechanisms as obesity (11, 38, 39). Recording BMI more frequently in this population might help prevent further weight gain or weight loss, as long as it is provided in a careful and empathetic manner, ensuring no discomfort to the patient or triggering feelings of shame.

In this study, a coded diagnosis of overweight and/ or obesity for a corresponding BMI was not commonly found in the EHR, which is consistent with the literature (40-42). Both diagnosing overweight and obesity and recording BMI are crucial: it results in prevention and early identification of overweight and obesity and can lead to weight loss (4, 42). Besides, it enables GPs when prescribing medication, writing referral letters, collaborating with colleagues (e.g., emergency services), discussing weight at follow-up, interpreting laboratory results and supports in risk management (6). A real-life example from the Netherlands shows it was clearly important and useful to have a recently accurate BMI recording: during the COVID-19 pandemic, GPs were asked to vaccinate patients with morbid obesity (BMI ≥ 40 kg/m^2) for COVID-19. GPs were unable to identify those patients, since BMIs were not recorded in the EHR.

To our knowledge, this is the largest population-based study from the Netherlands about recording practices of overweight, obesity, and recorded BMIs by Dutch GPs. This study, however, also has some limitations. First, our dataset is limited to a recorded height, weight, and BMI within the structured EHR, because we did not include free text data. It is likely that more BMIs (or weight and height) are recorded in free text in the EHR, as not all GPs translate their medical assessment to accurately coded recordings. So, our results could be an underestimation of available recorded BMIs. Second, it is important to note that routine healthcare data were used, showing limitations. To use this data accurately, we evaluated the data for extreme values and inconsistent records. Only less than 2% of the values were removed due to non-adequate or extreme values of height, weight, and BMI. Third, in this study, we cannot be sure that height and weight were actually measured. Some GPs inquire about height and weight and rely on the measurements provided by the patients themselves. Self-reported weight may be an underestimation, but in the majority of the cases the diagnosis of overweight and obesity is accurately identified (43).

Conclusion

Routinely recording BMI in the Netherlands is not currently standard practice since only one third of the adults in the Netherlands have a recorded BMI in their EHR. Incidence rates of recorded BMIs increased over the years from 2007 to 2023. Contributing factors to recording BMI are older age and chronic diseases such as COPD, DM2, hypertension and osteoarthritis. With the increasing prevalence of obesity and its related comorbidities, it should be considered to routinely record BMI in primary care in the Netherlands since it leads to early identification and treatment of obesity.

References

1. Guh DP, Zhang W, Bansback N, Amarsi Z, Birmingham CL, Anis AH. The incidence of co-morbidities related to obesity and overweight: a systematic review and meta-analysis. BMC Public Health. 2009;9:88.
2. Bhaskaran K, Douglas I, Forbes H, dos-Santos-Silva I, Leon DA, Smeeth L. Body-mass index and risk of 22 specific cancers: a population-based cohort study of 5·24 million UK adults. Lancet. 2014;384:755-65.
3. Warr W, Aveyard P, Albury C, Nicholson B, Tudor K, Hobbs R, et al. A systematic review and thematic synthesis of qualitative studies exploring GPs' and nurses' perspectives on discussing weight with patients with overweight and obesity in primary care. Obes Rev. 2021;22:e13151.
4. Ciemins EL, Joshi V, Cuddeback JK, Kushner RF, Horn DB, Garvey WT. Diagnosing Obesity as a First Step to Weight Loss: An Observational Study. Obesity (Silver Spring). 2020;28:2305-9.
5. Robinson E, Parretti H, Aveyard P. Visual identification of obesity by healthcare professionals: an experimental study of trainee and qualified GPs. Br J Gen Pract. 2014;64:e703-8.
6. van den Hout WJ, Adriaanse MA, Den Beer Poortugael LM, Mook-Kanamori DO, Numans ME, van Peet PG. Dutch GPs' perspectives on addressing obesity: a qualitative study. BJGP Open. 2024.
7. Ardesch FH, Meulendijk MC, Kist JM, Vos RC, Vos HMM, Kiefte-de Jong JC, et al. The introduction of a data-driven population health management approach in the Netherlands since 2019: The Extramural LUMC Academic Network data infrastructure. Health Policy. 2023;132:104769.
8. Kist JM, Vos HMM, Vos RC, Mairuhu ATA, Struijs JN, Vermeiren R, et al. Data Resource Profile: Extramural Leiden University Medical Center Academic Network (ELAN). Int J Epidemiol. 2024;53.
9. Westerhof H, Van AIthuis T. De zorgepisode als basisstructuur in de nieuwe generatie huisartsinformatiesystemen. Huisarts en Wetenschap. 1998;41(11): 515-9.
10. van den Hout WJ, Mook-Kanamori DO, van Peet PG, Büchner FL, Elzinga BM, Rosendaal FR, et al. Association of mental health and negative life events with weight change in patients with overweight: A cohort study. J Affect Disord. 2023;334:325-31.
11. Milaneschi Y, Simmons WK, van Rossum EFC, Penninx BW. Depression and obesity: evidence of shared biological mechanisms. Mol Psychiatry. 2019;24:18-33.
12. Nicholls D, Viner R. Eating disorders and weight problems. Bmj. 2005;330:950-3.
13. Eriksson B, Backman H, Bossios A, Bjerg A, Hedman L, Lindberg A, et al. Only severe COPD is associated with being underweight: results from a population survey. ERJ Open Res. 2016;2.
14. Nicholson BD, Aveyard P, Bankhead CR, Hamilton W, Hobbs FDR, Lay-Flurrie S. Determinants and extent of weight recording in UK primary care: an analysis of 5 million adults' electronic health records from 2000 to 2017. BMC Med. 2019;17:222.
15. Bhaskaran K, Forbes HJ, Douglas I, Leon DA, Smeeth L. Representativeness and optimal use of body mass index (BMI) in the UK Clinical Practice Research Datalink (CPRD). BMJ Open. 2013;3:e003389.
16. Rijksinstituut voor Volksgezondheid en Milieu (RIVM). Tijdlijn van coronamaatregelen 2020. https://www.rivm.nl/gedragsonderzoek/tijdlijn-van-coronamaatregelen-2020.
17. Homburg M, Brandenbarg D, Olde Hartman T, Ramerman L, Beugel G, Rijpkema C, et al. Patient experiences during the COVID-19 pandemic: a qualitative study in Dutch primary care. BJGP Open. 2022;6.
18. van Giessen A, de Wit A, van den Brink C. COVID-19 golf op de regulier zorg en gezondheid: Inventarisatie van de omvang van het probleem en eerste schatting van gezondheidseffecten. 2020.
19. McLaughlin JC, Hamilton K, Kipping R. Epidemiology of adult overweight recording and management by UK GPs: a systematic review. Br J Gen Pract. 2017;67:e676-e83.
20. Turner LR, Harris MF, Mazza D. Obesity management in general practice: does current practice match guideline recommendations? Med J Aust. 2015;202:370-2.

21. Baer HJ, Karson AS, Soukup JR, Williams DH, Bates DW. Documentation and diagnosis of overweight and obesity in electronic health records of adult primary care patients. JAMA Intern Med. 2013;173:1648-52.

22. Dutch College of General Practitioners. NHG Guideline of the Dutch College of General Practitioners: cardiovascular risk management (M84) (third update). 2024. https://richtlijnen.nhg.org/files/pdf/93_Cardiovasculair%20risicomanagement_september-2024.pdf.

23. Dutch College of General Practitioners. NHG Guideline of the Dutch College of General Practitioners: COPD (M26). 2022. https://richtlijnen.nhg.org/standaarden/copd.

24. Dutch College of General Practitioners. NHG Guideline of the Dutch College of General Practitioners: Diabetes mellitus type 2 (M01). 2023. https://richtlijnen.nhg.org/standaarden/diabetes-mellitus-type-2.

25. Cheema KM, Dicks E, Pearson J, Samani NJ. Long-term trends in the epidemiology of cardiovascular diseases in the UK: insights from the British Heart Foundation statistical compendium. Cardiovasc Res. 2022;118:2267-80.

26. Rijksinstituut voor Volksgezondheid en Milieu (RIVM). Sterfte naar doodsoorzaak | Internationaal. 2023. https://www.vzinfo.nl/sterfte-naar-doodsoorzaak/internationaal#sterfte-hart-vaatziekten.

27. Central agency of statistics of the Netherlands (CBS). Door de huisarts geregistreerde contacten; leeftijd en geslacht, 2006-2018. 2022. https://www.cbs.nl/nl-nl/cijfers/detail/80191ned.

28. Verberne LDM, Nielen MMJ, Leemrijse CJ, Verheij RA, Friele RD. Recording of weight in electronic health records: an observational study in general practice. BMC Fam Pract. 2018;19:174.

29. de Bakker DH, Struijs JN, Baan CB, Raams J, de Wildt JE, Vrijhoef HJ, et al. Early results from adoption of bundled payment for diabetes care in the Netherlands show improvement in care coordination. Health Aff (Millwood). 2012;31:426-33.

30. Tsiachristas A, Hipple-Walters B, Lemmens KM, Nieboer AP, Rutten-van Mölken MP. Towards integrated care for chronic conditions: Dutch policy developments to overcome the (financial) barriers. Health Policy. 2011;101:122-32.

31. Struijs JN, Baan CA. Integrating care through bundled payments--lessons from The Netherlands. N Engl J Med. 2011;364:990-1.

32. Kontopantelis E, Reeves D, Valderas JM, Campbell S, Doran T. Recorded quality of primary care for patients with diabetes in England before and after the introduction of a financial incentive scheme: a longitudinal observational study. BMJ Qual Saf. 2013;22:53-64.

33. INEEN. Denkraam integratie zorgprogramma's voor chronische aandoeningen. 2020. www.ineen.nl.

34. Brumpton B, Langhammer A, Romundstad P, Chen Y, Mai XM. The associations of anxiety and depression symptoms with weight change and incident obesity: The HUNT Study. Int J Obes (Lond). 2013;37:1268-74.

35. Luppino FS, de Wit LM, Bouvy PF, Stijnen T, Cuijpers P, Penninx BW, et al. Overweight, obesity, and depression: a systematic review and meta-analysis of longitudinal studies. Arch Gen Psychiatry. 2010;67:220-9.

36. Ibrahim M, Thearle MS, Krakoff J, Gluck ME. Perceived stress and anhedonia predict short-and long-term weight change, respectively, in healthy adults. Eat Behav. 2016;21:214-9.

37. de Wit LM, van Straten A, van Herten M, Penninx BW, Cuijpers P. Depression and body mass index, a u-shaped association. BMC Public Health. 2009;9:14.

38. van der Bij S, Khan N, Ten Veen P, de Bakker DH, Verheij RA. Improving the quality of EHR recording in primary care: a data quality feedback tool. J Am Med Inform Assoc. 2017;24:81-7.

39. Alshehri T, Boone S, de Mutsert R, Penninx B, Rosendaal F, le Cessie S, et al. The association between overall and abdominal adiposity and depressive mood: A cross-sectional analysis in 6459 participants. Psychoneuroendocrinology. 2019;110:104429.

40. Booth HP, Prevost AT, Gulliford MC. Epidemiology of clinical body mass index recording in an obese population in primary care: a cohort study. J Public Health (Oxf). 2013;35:67-74.

41. Noël PH, Copeland LA, Pugh MJ, Kahwati L, Tsevat J, Nelson K, et al. Obesity diagnosis and care practices in the Veterans Health Administration. J Gen Intern Med. 2010;25:510-6.

42. Bardia A, Holtan SG, Slezak JM, Thompson WG. Diagnosis of obesity by primary care physicians and impact on obesity management. Mayo Clin Proc. 2007;82:927-32.

43. Bowring AL, Peeters A, Freak-Poli R, Lim MS, Gouillou M, Hellard M. Measuring the accuracy of self-reported height and weight in a community-based sample of young people. BMC Med Res Methodol. 2012;12:175.

Supplemental table 1 Results of the cox regression of the association between age categories and a recorded body mass index

Age category (years)	HR (95% CI)	HR (95% CI)*
19-30	reference	reference
31-40	1.34 (1.31-1.37)	1.11 (1.08-1.13)
41-50	2.58 (2.54-2.63)	1.10 (1.07-1.11)
51-60	4.90 (4.81-4.98)	1.29 (1.27-1.31)
61-70	7.81 (7.68-7.95)	1.55 (1.53-1.58)
71-80	10.38 (10.20-10.57)	1.96 (1.93-2.00)
81+	8.86 (8.69-9.04)	2.07 (2.03-2.11)

HR: hazard ratio, CI: confidence interval. *Adjusted for the calendar year in which the body mass index was recorded