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Availability and utility of body mass index for population-based cancer surveillance

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Abstract

Objective—To evaluate the availability of body height and weight in the hospital medical record of cancer patients and discuss the utility of the findings to population-based cancer research and the surveillance of overweight and obesity in the United States.

Methods—Medical records were reviewed for up to three measures of height and weight for a random sample of 1,739 patients diagnosed (2001–2003) with one of 12 types of cancer and reported to the population-based Greater Bay Area Cancer Registry of Northern California.

Results—84% of cancer patients had at least one value of height, 91% had at least one value of weight, and 83% had both values recorded in the medical record such that body mass index (BMI) could be computed. 60% of height and weight values were recorded within two months of cancer diagnosis, with most values (71%) recorded after cancer diagnosis. The availability of BMI varied somewhat by race/ethnicity, cancer site, initial treatment, and hospital characteristics.

Conclusions—BMI may be sufficiently available to be included routinely in population-based cancer registries, and, if so, would be useful for studies of cancer diagnoses and outcomes and permit nationwide surveillance of BMI in a large population-representative cohort of cancer patients.

Keywords

body mass index; body weight; body height; cancer; surveillance

Introduction

The surveillance of disease and health risk factor prevalence in the United States (US) is currently facilitated by three large surveys [the National Health Interview Survey (NHIS), National Health and Nutrition Examination Survey (NHANES), and Behavioral Risk Factor Surveillance System (BRFSS)] conducted in random samples of the general US population. Results from these surveys suggest that rates of overweight and obesity, commonly derived from height and weight and expressed by body mass index (BMI, kg/m²), have been increasing for many decades (1–7). In data from NHANES for the periods 1988–1994 and 1999–2000, the age-adjusted prevalence of obesity (BMI ≥ 30) increased from 22.9% to 30.5%, while overweight (BMI ≥ 25) increased from 55.9% to 64.5% (2). These increases, observed in all age, sex, and racial/ethnic groups (2), pose a major growing public health problem given that obesity is a risk factor for many chronic conditions and certain cancers (2,8).

In the US, cancer surveillance has been conducted continuously since 1973 by the Surveillance, Epidemiology and End Results (SEER) program of the National Cancer Institute (NCI), a population-based network of cancer registries currently covering 26% of the US population

(9). In addition, since 1992, the National Program for Cancer Registration (NPCR), supported by the Centers for Disease Control and Prevention (CDC), has mandated that cancer registries operate in all states (9). These cancer surveillance programs identify and obtain prescribed demographic, tumor and clinical information on newly diagnosed cancer patients; together they are essential tools for understanding factors that affect cancer occurrence and prognosis, and provide information on the cancer burden for public health research and education and for cancer prevention and control (9).

Data from population-based cancer registries also serve as an important resource for tracking trends in sociodemographic risk factors associated with cancer occurrence and prognosis. Despite the established association between excess BMI and a variety of cancers (10–12), data for calculating BMI are not currently collected by the SEER or NPCR cancer programs. However, routine availability of this information in population-based cancer registries could enhance the ability of researchers to monitor and further understand the contribution of BMI to cancer incidence or outcomes, depending on the timing of these measurements. It could also provide the ability to assess the impact of programs designed to reduce overweight/obesity in cancer survivors, a group prone to cardiovascular disease, diabetes, arthritis, osteoporosis and second primary cancers (13–18), and to provide nationwide surveillance of BMI in a large population-representative cohort of cancer patients.

Only one prior study has presented the availability of height and weight in hospital records of cancer patients (19), but did not consider how this availability varied by patient, tumor, or hospital characteristics or the timing of these measurements. Therefore, to determine the feasibility of collecting BMI in cancer patients on a population basis, we undertook a study to evaluate the availability of body height and weight in the hospital medical record--the primary data source for most cancer-registry information on a cancer diagnosis--of cancer patients in the Greater Bay Area Cancer Registry (GBACR), a participant in the SEER program, and the California Cancer Registry (CCR). In this paper, we present the findings of this study and discuss the utility of the findings to cancer research and the general surveillance of overweight and obesity in the US.

Materials and Methods

The study sample included 1,739 cancer patients reported to the GBACR who were residing in one of the registry's catchment area counties (San Francisco, Alameda, Contra Costa, Marin, San Mateo, Santa Clara, Santa Cruz, Monterey, and San Benito counties) at diagnosis during the time period 2001–2003. Cases were identified from two registry-based samples. The first sample consisted of a random sample of cases across eight cancer sites from 13 hospitals. These cancer sites were chosen to include cancers with known associations to BMI [ovarian (n=109), prostate (n=114), colorectal (n=213), melanoma (n=198), lung and bronchus (n=218)] (8,10–12,20–22); cancers without known associations to BMI [liver (n=177), stomach (n=193), acute lymphocytic leukemia (n=50)]; and a cancer that occurs in children/young adults (acute lymphocytic leukemia). We selected hospitals so that both large (≥ 200 hospital beds) and small (< 200 hospital beds), public and private ownership, and teaching and non-teaching hospitals were represented. Because multiple hospitals had these characteristics, and in order to improve cost efficiency, we included hospitals that had participated in registry-based studies in the past and had at least 50 patients diagnosed with the selected cancers. Hospitals were considered teaching hospitals if they met two of the following criteria: a) approval to participate in residency or internship training by the Accreditation Council for Graduate Medical Education; b) medical school affiliation, reported to the American Medical Association; or c) member of the Council of Teaching Hospitals of the Association of American Medical Colleges. The second registry-based sample consisted of adults 20 years and older included in the SEER Patterns of Care (POC) study (23), a medical record abstraction study that randomly selected

cases from all 63 regional hospitals that were diagnosed in 2003 with cancer at one of four sites: bladder (n=122), multiple myeloma (n=114), non-Hodgkin lymphoma (n=178) and chronic myelogenous leukemia cases (n=37).

For all study patients, hospital medical records were reviewed by experienced abstractors, who were asked to record up to three measures of height and weight, the date of these measures, the location of these measures in the medical record, and the total time required to abstract this information. We requested values recorded one to two years prior to diagnosis, but also accepted values at the time of, or after, diagnosis if values prior to diagnosis were not available. We were not able to abstract height and/or weight from a few patients whose charts were either missing (n=64) or in storage (n=8). Bivariate associations between the presence of height and weight data and patient, tumor, and hospital characteristics were tested statistically by the chi-square test, with differences considered significant at $p < 0.05$. The institutional review board of the Northern California Cancer Center approved this project.

Results

Hospital medical record review for the 1,739 cases found that 84.0% had at least one value of height, 90.6% had at least one value of weight, and 83.2% (n=1,446) had at least one value of height and weight recorded such that BMI could be computed; 8.6% (n=149) of cases were missing both height and weight information. We found approximately 50% of height and weight values recorded in the admission records, anesthesia notes and nurse's notes, although these measures were also found throughout the medical record. Across all sampled cancer sites, it took a mean time of 6.8 minutes (standard error=0.2 minutes) and median time of five minutes (standard deviation= 6.0 minutes) to review each medical record and record up to three measures of height and weight.

Among cases with height and weight values, 29.4% had one value of each, while 58.2% and 69.4% of cases had more than one value of height and weight, respectively. Approximately half of the cases with multiple values of height and/or weight had these values recorded on the same day (52.6% for height and 46.8% for weight). Height values measured on the same day were highly consistent (98.9% of measurements were the same); for cases with measurements that differed (n=16), the mean differences between two or three height measures ranged from 0.014 to 0.026 m (median ranged from 0.002 to 0.025 m). Weight values measured on the same day were also very consistent (95.3% of measurements were the same); for cases with measurements that differed (n=68), the mean differences between two or three weight measures ranged from 2.5 to 4.0 kg (median ranged from 0.4 to 1.8 kg). On average, 60.2% of cases had weight available within two months of diagnosis, with 71.0% having weight recorded after diagnosis; only 4.9% of cases had weight available more than 12 months before diagnosis (Figure 1). Results were similar for height (Figure 2). For cases with weight values measured within two months prior to and after diagnosis (n=210), the mean (3.0 kg) and median (1.4 kg) differences between these values were generally small (three outliers, weight differences > 45.3 kg, were excluded).

When we compared cases who had both height and weight values to those lacking one or both measurements (Table 1), we found no differences across age, sex or most cancer sites. However, reporting of height and weight was significantly less likely for cases with melanoma and more likely for patients with ovarian cancer; less likely for whites and more likely for Asian Pacific Islanders; more likely for cases undergoing chemotherapy and surgery than those not receiving these treatments; less likely for teaching than non-teaching hospitals; more likely for small than large hospitals; and more likely for private than public hospitals.

Discussion

In our study of the availability of body size measures in hospital medical records of men and women with a variety of newly diagnosed cancers reported to a population-based cancer registry, we found height and weight to be available for the majority (84%) at or near the time of diagnosis. The availability of height and weight varied by some characteristics, including cancer type, type of treatment received, and hospital characteristics. Our overall results are similar to those from the Connecticut Cancer Registry, also a participant in the SEER program, which found 79% of a random sample (n=618) of invasive cancer patients to have height and weight recorded in hospital admissions records at cancer diagnosis (19). To our knowledge, no other studies have assessed the availability of this information in the medical records of cancer patients, however, in a study of non-cancer patients, 63% of adults (n=465) scheduled to receive care at a community health center over a one-week period had height, at any time, and weight, within the prior 6 months, recorded in the medical record (24).

While the availability of BMI is better in our study than in the study of adults without cancer, the limitation of data availability to the time of diagnosis presents some challenges and opportunities for research. Establishing the influence of BMI on cancer etiology requires values of BMI obtained at least 1–2 years prior to cancer diagnosis and ideally at various earlier times throughout life. Many studies have established the relationship between pre-morbid values of BMI and the occurrence of cancers of the breast, cervix, endometrium, uterus, ovary, colon, prostate, esophagus, and kidney (25–27). Because the cancer itself may influence BMI, measurements taken at or near diagnosis may not accurately reflect the earlier BMI values that are most relevant to cancer risk. Therefore, our data suggest that we cannot currently collect BMI for studies of cancer etiology. However, BMI measured near diagnosis can be useful for studies of cancer outcomes (e.g., survival, multiple primary cancers). In addition to considering associations between BMI and details of cancer diagnosis (e.g., stage at diagnosis or other tumor characteristics) or initial treatment, the prognostic value of BMI within stage of diagnosis or treatment, for example, can also be considered. Previous research utilizing measures near diagnosis have found independent associations between larger body size and poorer breast cancer prognosis, with possible mechanisms related to hormones (e.g., excess leptin, insulin, or estrogen production), nutrition (e.g., dietary fat and caloric intake) or treatment (28–32). Specifically, overweight and obesity have been associated with chemotherapy dose reduction below that recommended for optimal treatment (33–35), which may subsequently impact survival due to poorer treatment efficacy (34,36). In addition, higher BMI has been found to be associated with increased axillary node involvement in postmenopausal women (37) and in women with ER-positive tumors (38), and has been associated with late-stage breast cancer diagnosis (29,39–41).

The addition of BMI as routinely collected data for population-based cancer registries would allow the associations between BMI and the cancer outcomes mentioned above to be evaluated over time by correlates of interest such as age and race/ethnicity, area-level socioeconomic factors, and tumor characteristics in a large and population-representative cohort of cancer patients. Because health risk factors often vary by patient characteristics, having BMI available in the large cohort of patients would allow researchers to track BMI over time in smaller populations more homogenous for risk factors and outcomes. Additionally, because of the increasing linkage of cancer registries with other electronic databases (42), there is potential for new avenues of research with regards BMI; these opportunities may include the evaluation of associations between BMI and access to and quality of medical care, screening practices, environmental exposures, co-morbidities and more detailed treatment after cancer diagnosis, as well as the associations of BMI and these factors with survival after cancer diagnosis. Furthermore, the surveillance of BMI would provide an opportunity to evaluate the impact of policy changes or interventions aimed at reducing overweight/obesity in cancer patients, and

may aid in setting weight management guidelines in cancer survivors. If the BMI of cancer patients is found to be similar to patients in the general population, possibly through comparisons to data from other health surveys, then observed trends could be informative to local, state and national health agencies.

A limitation of our study was the restriction of our data collection to hospital medical records. Hospital medical records were the primary source of cancer registry information for 92.3% of patients diagnosed with the cancer sites considered in this study in the state of California (2001–2003). Nevertheless, physician records (5.5%) and other sources (<1% for each for laboratories, nursing homes, autopsy only or death certificates) were the primary source for the remaining patients. Because we did not abstract information from these other sources, it is possible that we underestimated the availability of BMI or that the availability of BMI varied by additional characteristics other than the patient, tumor and hospital characteristics found in our study. Therefore, increasing the presence of BMI in all medical records will be necessary to permit complete data for cancer registration.

Including BMI data in cancer registries could reduce two sources of bias commonly present in health surveys. First, is the bias associated with the use of self-reported data, as self-reported BMI has been shown to underestimate measured BMI (43–45). Although we could not determine whether the height and weight values were self-reported or measured in our study, an investigation of the validity of weight in medical charts found body weight reported in the record to have better accuracy than self-reported values (46). Secondly, data from health surveys (e.g., BRFSS) conducted by phone or using a phone for sampling purposes exclude people who do not have a traditional landline. Because of the increase in cellular phone use, which has more than doubled since 2000 (47) and often replaces land-line telephones, excluding people without land-line telephones could result in selection bias if their BMI differed from that of people with a land-line telephone.

In considering the possibility of implementing routine collection of BMI for cancer registries, one must also consider the additional time and cost involved in adding these data, and the relative priority of BMI over other novel factors (e.g., education, tumor biomarkers, comorbidities). For example, abstracting height and weight for each cancer patient in our study required a median of 5 minutes, so for 27,117 cases (the number of cases diagnosed in California in 2003), an additional annual full-time equivalent of 1.14 employees would be needed, assuming each employee worked 1,978 hours per year, the average annual hours worked in the US in 2000 (48). With the increasing movement towards electronic medical records, data collection for cancer registration should become quicker and eventually automated, so the addition of BMI to mandated routine collection and possibly the accessibility of pre-diagnostic BMI may be more feasible in the future. However, time and funds are also required to initiate the incorporation of new data items into the registry (e.g., setting standards for systematic data collection, training abstractors, programming additional data items into the databases, and checking data quality). Unlike the measurement of some other data items, measurement of weight is sensitive to timing, so specific guidelines for abstraction will be necessary to standardize this measurement (e.g., the measure must be within two months of diagnosis).

Our study found BMI to be readily available in the hospital medical record of most cancer patients at the time of diagnosis. BMI measured at diagnosis, if included in population-based cancer registration, would be useful for studies of cancer outcomes, particularly when combined with other cancer registry data, such as stage of disease at diagnosis and treatment. In addition, data available in medical records, which may be a less biased measure than self-reported BMI, could provide nationwide surveillance of BMI in a large population-representative cohort of cancer patients. With rates of overweight and obesity continuing to

increase in the US, the collection of BMI data should be a priority for cancer registries because of the importance of this data for health surveillance and research.

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Figure 1. Date of up to three height measures available in the medical record relative to cancer diagnosis for cases with at least one value of height and weight (n=1446), Greater Bay Area Cancer Registry, California, 2001–2003.

Figure 2.

Date of up to three weight measures available in the medical record relative to cancer diagnosis for cases with at least one value of height and weight (n=1446), Greater Bay Area Cancer Registry, California, 2001–2003.

Table 1

Presence of patient height and weight in the medical record by patient, tumor, and hospital characteristics, Greater Bay Area Cancer Registry, California, 2001–2003.

Patient, tumor, and hospital characteristics	Presence of height and weight		<i>p</i> -value (difference)
	Yes* N=1,446 %# (n)	No** N=293 %# (n)	
Age at diagnosis (years)			
0–19	72.0 (18)	28.0 (7)	
20–49	81.9 (212)	18.1 (47)	
50–64	83.5 (420)	16.5 (83)	
65–74	83.6 (347)	16.4 (68)	
75+	83.6 (449)	16.4 (88)	<i>p</i> = 0.61
Sex			
Male	83.3 (803)	16.7 (161)	
Female	83.0 (642)	17.0 (132)	
Other	100.0 (1)		<i>p</i> = 0.89
Cancer site			
Chronic myeloid leukemia	86.5 (32)	13.5 (5)	<i>p</i> = 0.58
Non-Hodgkin lymphoma	83.2 (148)	16.8 (30)	<i>p</i> = 1.00
Acute lymphocytic leukemia	82.0 (41)	18.0 (9)	<i>p</i> = 0.83
Bladder	88.5 (108)	11.5 (14)	<i>p</i> = 0.10
Colorectal	84.5 (180)	15.5 (33)	<i>p</i> = 0.57
Liver	83.6 (148)	16.4 (29)	<i>p</i> = 0.86
Lung and bronchus	84.9 (185)	15.1 (33)	<i>p</i> = 0.47
Melanoma	69.2 (148)	30.8 (66)	<i>p</i> = 0.00
Multiple myeloma	81.6 (93)	18.4 (21)	<i>p</i> = 0.64
Ovarian	91.7 (100)	8.3 (9)	<i>p</i> = 0.01
Prostate	86.0 (98)	14.0 (16)	<i>p</i> = 0.41
Stomach	85.5 (165)	14.5 (28)	<i>p</i> = 0.36
Race/ethnicity			
Non-Hispanic White	79.9 (688)	20.1 (173)	
Non-Hispanic Black	85.6 (119)	14.4 (20)	
Hispanic	81.6 (186)	18.4 (42)	
Asian Pacific Islander	88.7 (440)	11.3 (56)	
NH American Indian	66.7 (2)	33.3 (1)	
Other/unknown	91.7 (11)	8.3 (1)	<i>p</i> = 0.00
Vital status [±]			
Alive	81.8 (806)	18.2 (179)	
Dead	84.9 (640)	15.1 (114)	<i>p</i> = 0.09
Hospital ownership status			
Public/other	79.9 (438)	20.1 (110)	

Patient, tumor, and hospital characteristics	Presence of height and weight		
	Yes* N=1,446 %# (n)	No** N=293 %# (n)	p-value (difference)
Private	84.6 (1008)	15.4 (183)	$p = 0.01$
Teaching hospital			
Yes	77.0 (567)	23.0 (169)	
No	87.6 (879)	12.4 (124)	$p = 0.00$
Hospital size			
Small (<200 beds)	92.7 (570)	7.3 (45)	
Large (≥ 200 beds)	77.9 (876)	22.1 (248)	$p = 0.00$
Chemotherapy			
Yes	86.0 (576)	14.0 (94)	
No	80.4 (787)	19.6 (192)	
Unknown	92.2 (83)	7.8 (7)	$p = 0.00$
Radiation therapy			
Yes	85.9 (250)	14.1 (41)	
No	82.6 (1196)	17.4 (252)	$p = 0.17$
Surgery			
Yes	84.5 (976)	15.5 (179)	
No	80.5 (470)	19.5 (114)	$p = 0.03$

* Complete: at least one measure of height and weight present in the medical record

** Incomplete or partially complete: no measures of height or weight or only one of height or weight present in the medical record

Row percentage

$\pm$ Vital status as of 11/22/2005