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Original article

Waist circumference, waist-hip ratio, body mass index, and prostate cancer risk: Results from the North-American case-control study Prostate Cancer & Environment Study

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Abstract

Introduction: The evidence on the association between anthropometric measures quantifying body fatness and prostate cancer (PCa) risk is not entirely consistent. Associations among waist circumference (WC), waist-hip ratio, body mass index (BMI), and PCa risk were assessed in a population-based case-control study.

Patients and methods: The study included 1933 incident PCa cases diagnosed between 2005 and 2009. Population controls were 1994 age-matched (±5 y) Montreal residents selected from electoral lists. Information on sociodemographics, medical history including PCa screening, height, weight, and waist and hip circumferences was collected through interviews. Logistic regression was used to assess odds ratios (ORs) for the association between anthropometric measures, and overall and grade-specific PCa.

Results: After adjustment for BMI, an excess risk of high-grade PCa (Gleason ≥7) was associated with a WC ≥102 cm (OR = 1.47 [1.22–1.78]) and with a waist-hip ratio >1.0 (OR = 1.20 [1.01–1.43]). Men with a BMI ≥30 kg/m^2 had a lower risk of PCa, regardless of grade. Restricting to subjects recently screened for PCa did not alter findings.

Conclusion: Elevated BMI was associated with a lower risk of PCa, regardless of grade. Contrastingly, abdominal obesity, when adjusted for BMI, yielded results in the opposite direction. Taken together, our observations suggest that the specific body fat distribution (abdominal), for a given BMI, is a predictor of PCa risk, whereas BMI alone is not. BMI and abdominal obesity, especially when measured by the WC, should be examined conjointly in future studies on this issue and may require consideration at patient counseling.

Keywords: Prostate cancer; Obesity; Waist circumference; Waist-hip ratio; Body mass index; Abdominal fat; Case-control study

1. Introduction

Obesity and overweightness are on sharp rise in western countries. In 2009 to 2010, 77% of North-American men older than 60 years were classified as overweight (body mass index [BMI]: 25–29.9 kg/m^2) or obese (BMI ≥ 30 kg/m^2) [1]. Obesity is associated with an increased risk of several cancers, such as colorectal and breast cancers [2]. Anthropometric measures of body fatness include BMI, waist circumference (WC), and waist-hip ratio (WHR).

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However, inconsistent results have been reported with respect to the association between obesity and PCa risk [3–6]. Specifically, in a large case-control study from Europe [7], increased BMI was inversely related to low-grade PCa risk and no relationship was found between BMI and high-grade PCa [7]. Similar results were also found in a prospective cohort study [8]. The same study showed results in the opposite direction when obesity and high-grade PCa were examined, similar to those of other authors [9]. Conversely, a European prospective cohort study showed no association between elevated BMI and risk of PCa, regardless of grade [10]. The lack of consensus regarding the magnitude and direction of the association between BMI and PCa risk is still debatable. In consequence, it is possible that the relationship between BMI and PCa varies from one population to another or that BMI alone is a poor indicator for obesity and other anthropometric measures alone, or in combination with BMI, might better illustrate body fat distribution.

Several hypotheses have been proposed to explain an inverse relationship between BMI and PCa risk. First, it may ensue from lower PCa detection rates among men with elevated BMI, due to a dilutional effect of PSA in men with BMI elevation [11–15]. Second, it is also known that the metabolic syndrome, of which abdominal obesity is an integral part, is associated with a lower risk of PCa diagnosis [16,17]. Third, obesity may also be correlated with a low physical activity, which is possibly associated with PCa [18].

However, the latest evidence linking anthropometric measures and PCa risk was recently reviewed by the World Cancer Research Fund International organization [3]. Although no conclusion could be drawn for total or nonadvanced PCa, recent data were suggestive of a dose-response trend between each of these indicators and the risk of advanced PCa.

Based on this, we examined the association between various anthropometric measures of body fatness and PCa risk in a study population constituted of men from Montreal, Canada.

2. Patients and methods

2.1. Study population

We relied on data from the population-based case-control study Prostate Cancer & Environment Study (PROtEuS), which recruited subjects in Montreal, Canada, between 2005 and 2012. The study design was previously described [19–21]. In brief, the study population consisted of residents of Montreal metropolitan area, aged <76 years at diagnosis or recruitment. Cases consisted of histologically confirmed, newly diagnosed PCa and were actively ascertained through pathology departments across 7 hospitals in Montreal between 2005 and 2009, covering $>80\%$ of all cases diagnosed in the catchment area. Controls had no PCa diagnosis at the time of interview. Age-matched (5-y intervals) controls from the same residential area were randomly selected. Participation rates were 79.4% for cases and 55.5% for controls. In analyses comparing sociodemographic characteristics of participants and nonparticipants, little differences emerged. Committees of all participating institutions approved the study protocol and all subjects provided informed consent.

2.2. Measures

Subjects provided information about sociodemographic characteristics, lifestyle, and their medical history, including the frequency of PSA measurements and digital rectal examinations (DRE), physical activity (not very active, moderately active, and very active), and presence of diabetes (yes/no) by interviews. Anthropometric factors included self-reported current height and weight 2 years before the index date (i.e., diagnosis or interview), referred to as recent BMI. The interviewer measured waist (1 in above the umbilicus) and hip circumferences (maximum) in a standardized fashion. Missing values were recorded in 323 and 328 patients for WC and WHR, respectively. For cases, information about Gleason scores and PSA levels at diagnosis was extracted from patient's files and pathology reports.

2.3. Statistical analyses

Our analyses focused on 3 anthropometric indicators of body fatness as potential risk factors: (1) WC, (2) WHR, and (3) recent BMI. WHR was calculated by dividing the waist by the hip circumference. For WC, a cutoff of 102 cm was used to define abdominal obesity, as recommended by the World Health Organization [22]. The cutoff for analyses on WHR was set at 1.0, according to the distribution among controls (mean $=$ 0.99 and median $=$ 1.0). Sensitivity analyses were performed, using 2 different cutoffs (0.97 and 1.02), based on tertiles among controls.

BMI was calculated as recent weight divided by the square of the height. BMI was categorized according to the definition of the World Health Organization, into underweight (BMI $<$ 18.5), normal weight (BMI: 18.5–24.9), overweight (BMI: 25.0–29.9), obese class I (BMI: 30.0–34.9), obese class II (BMI: 35.0–39.9), and extreme obesity (BMI $>$ 40). For analyses, we combined the underweight and normal weight categories, as well as the obese class I, class II, and extreme obesity categories.

Unconditional logistic regression was used to test associations between the 3 anthropometric measures and PCa risk. All models included age at index date, PCa family history in first-degree relatives, ancestry (European, Black, Asian, other, and unknown), physician visits per year (<1, 1–3, >3, and unknown), and number of PSA measurements within the 5 years preceding PCa diagnosis/interview (≤ 4 PSA tests, >4 PSA tests, and unknown).

Multivariate logistic regression was used to assess associations with overall PCa risk. Multinomial logistic regression was applied for analyses considering low-grade (Gleason ≤ 6) or high-grade (Gleason ≥ 7) PCa. Additional