Adenoma Detection Rates for Screening Colonoscopies in Smokers and Obese Adults: Data from the New Hampshire Colonoscopy Registry

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Abstract

Goal—To examine screening adenoma detection rates (ADR) and serrated detection rates (SDR) among smokers and obese adults in the New Hampshire Colonoscopy Registry.

Background—ADR, a quality measure for screening colonoscopies, is associated with protection from interval colorectal cancer (CRC). Currently, only sex-specific ADR benchmarks are reported. However, obesity and smoking 20 pack-years are strong predictors for colorectal neoplasia, as highlighted by the 2009 American College of Gastroenterology CRC Screening Guidelines. Data comparing ADR in smokers and obese adults to those without these risks are limited.

Study—We calculated ADR, SDR and 95% confidence intervals for screening colonoscopies in participants 50 years. Sex and sex-age specific rates were compared by smoking exposure (never versus < 20 pack-years versus 20 pack-years) and body mass index (BMI < 30 versus BMI 30).

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Conflict of interests: The authors have no conflicts of interest to declare.

Results—21,539 screening colonoscopies were performed by 77 endoscopists at 20 facilities (4/2009 -9/2013). The difference in ADR between non-smokers and smokers with   20 pack-years was 8.8% (p < 0.0001) and between obesity groups 5.0% (p<0.0001). Significant sex specific and sex-age specific increases in ADR and SDR were found among smokers and obese participants.

Conclusions—ADR and SDR for smokers and obese adults were significantly higher than their counterparts without those risks. Endoscopists should consider the prevalence of these risks within their screening population when comparing their rates to established benchmarks. Calculating sex or sex-age specific ADR and SDR based on smoking and obesity may provide optimal protection for populations with a particularly high prevalence of smokers and obese adults.

Introduction

The adenoma detection rate (ADR), introduced as a method for measuring the quality of screening colonoscopies[1,2], has been shown to be inversely associated with interval cancer rates[3,4]. The ADR is defined as the proportion of screening colonoscopies in which one or more adenomas or colorectal cancers are detected. Recent recommendations suggest that endoscopists achieve an overall ADR of 25%[5].

The recent joint American College of Gastroenterology (ACG) and American Society for Gastrointestinal Endoscopy (ASGE) paper on quality indicators for colonoscopy[5] states that the principal factor that influences ADR in average-risk adults is sex, as supported by other studies[6]. Accordingly, the primary consideration in setting ADR benchmarks for screening exams in adults 50 years or older is sex, with recommendations that endoscopists achieve a mean ADR of 30% for men and 20% for women. Guideline recommendations do not take into account other factors that influence adenoma prevalence, such as smoking or obesity[5], two factors which were highlighted in the recent ACG CRC screening guidelines[7]. Consideration was given to recommend that CRC screening should begin at age 45 years for both groups but the ACG guidelines concluded that additional study was warranted. Both factors have also been shown to be associated with an increased risk for adenomas[8-12], with one meta-analysis finding an almost two-fold increase in adenoma risk among smokers[13].

Data examining the ADR in smokers and obese adults are limited. Our goal was to use data from the New Hampshire Colonoscopy Registry (NHCR) to compare the ADR in screening colonoscopies conducted in obese adults and smokers to those in individuals without these risk factors. Given the association between the serrated pathway and a large proportion of CRC[14] as well as interest in using the detection of serrated polyps as a potential quality measure for colonoscopy[15,16], we also examined the serrated polyp detection rates (SDR) in these risk groups.

Methods

The NHCR[17-20] is a population-based, statewide registry collecting data from endoscopy sites throughout New Hampshire (NH). Prior to colonoscopy, consenting patients complete a self-administered patient questionnaire. Participants are queried about their smoking history[21], including questions about current smoking status (never, past or current), number of years smoked, and the number of cigarettes per day if applicable. Body mass index (BMI) is calculated from the participant's self-report of height and weight.

The NHCR Procedure Form is completed during or immediately following colonoscopy by endoscopists or endoscopy nurses. Data collected include screening (with three detailed options: no symptoms and no family history of polyps or CRC, family history of polyp(s), or family history of CRC with specification of first degree relative), surveillance or diagnostic indication for the colonoscopy, findings (location, size and specific treatment of polyps, cancer, or other findings), type and quality of bowel preparation, sedation medication, anatomical location reached during the procedure, withdrawal time, follow-up recommendations, and immediate complications.

The NHCR requests pathology reports for all colonoscopies with findings directly from the pathology laboratory used by each participating endoscopy facility. Trained NHCR staff abstract and enter these pathology reports, including location, size, and histology of each polyp, into the NHCR database, linking individual polyp level data to information from the Procedure Form.[19] All data collection and study procedures were approved by the Committee for the Protection of Human Subjects at Dartmouth College (study # 00015834), as well as by other relevant human subjects reviewing bodies at participating sites.

Cohort

Our analysis involved selecting screening colonoscopies from a total of 52,739 colonoscopies performed from 4/6/2009 to 9/13/2013 at 20 endoscopy facilities, including hospitals, ambulatory surgery centers, and community practices across NH. Since our intent was to examine the ADR for screening colonoscopies, surveillance colonoscopies (N = 15,661), diagnostic colonoscopies (N = 10,237) and colonoscopies with no indication (N = 2,129) were not included in this analysis[22]. A surveillance indication was specified for a colonoscopy performed on patients with a personal history of CRC and/or personal history of polyps and on patients with familial polyposis or hereditary non-polyposis colon cancer or inflammatory bowel disease (IBD). An indication of diagnostic included evaluation of gastrointestinal bleeding, ruling out IBD, biopsy of suspected cancer, follow-up of a positive fecal occult blood test, abnormal virtual colonoscopy or barium enema test, polypectomy of known polyp and iron deficiency anemia. As shown in Figure 1, there were 24,712 screening colonoscopies.

Since average-risk CRC screening begins at age 50 and the guideline benchmarks apply to individuals aged 50 years and older,[5,23] we excluded colonoscopies among patients less than 50 years of age at the time of colonoscopy (N = 1,709). We also excluded colonoscopies for which sex of the participant was missing (N = 39), colonoscopies with a poor colonic preparation (N = 410) and incomplete colonoscopies (N = 1,015). After excluding 3,173

colonoscopies, 21,539 screening colonoscopies performed by 77 endoscopists comprised our study cohort.

Risk Factors

The variables of interest were sex, age at screening colonoscopy, and the patient's self-reported risk factors of smoking and body mass index (BMI). Consistent with the ACG CRC Screening Guidelines[7], we defined smokers into three groups: 20 pack years, < 20 pack years, or never smoked, and classified patients as obese (BMI 30) or not obese (BMI < 30). Age at the time of screening colonoscopy was categorized into two groups (50-59 and 60).

Outcome Measures

We calculated the ADR (the number of colonoscopies with at least one adenoma or adenocarcinoma detected, divided by the total number of colonoscopies), and 95% confidence interval (95% CI), for screening colonoscopies. In calculating the ADR, the numerator contained all colonoscopies in which at least one lesion with adenomatous tissue was detected, including tubular, tubulovillous or villous adenomas, and adenomatous polyps with high grade dysplasia, intra-mucosal carcinoma or invasive adenocarcinoma.

Our calculation for SDR was similar to that for ADR. The numerator for our calculation was the number of screening colonoscopies with at least one serrated lesion. Based on recent studies[15,16] as well as the expert panel guidelines[24], we defined a serrated lesion for the purpose of calculating SDR as any sessile serrated polyp or adenoma (SSP/A), traditional serrated adenoma (TSA), or hyperplastic polyp, proximal to the sigmoid. The denominator, as in the ADR calculation, was the total number of screening colonoscopies.

Analysis

We report overall, sex specific and sex-age specific ADR, SDR and 95% confidence intervals (95% CI), by smoking status and BMI. The chi-square test and two-sample tests of proportions were performed to assess differences in ADR and SDR for smoking and BMI groups. A p-value <0.05 was considered statistically significant. The analyses were conducted in SAS (SAS Institute Inc. 2015. SAS® 9.4 System Options: Reference, Fourth Edition. Cary, NC: SAS Institute Inc.) and STATA (StataCorp. 2011. Stata Statistical Software: Release 12. College Station, TX: StataCorp LP).

Results

The study cohort had a mean (±SD) age of 58.2 (±7.7) years, and was 56% female. Forty-seven percent of the participants were smokers and 33.8% were obese (BMI 30). Less than 4% of patients did not complete the patient questionnaire, and information on the number missing relevant covariate data (smoking status and BMI) is provided in the footnotes to Tables 1 - 3.

Shown in Table 1, the overall screening ADR (95% CI) was 23.6% (23.0% - 24.2%). A small proportion (0.1%) of the overall screening ADR was attributable to CRC (n=27). The

sex specific ADR was 30.2% (29.3% - 31.2%) for males and lower among females at 18.4% (17.7% - 19.1%). The ADR for screening colonoscopies among smokers with more than 20 pack years (29.8% (28.5% - 31.0%)), was significantly higher than for screening colonoscopies among those who smoked less than 20 pack years (22.1% (20.9% - 23.4%)) or who never smoked (21.0% (20.2% - 21.8%)), a pattern that held true within patient sex groups. The difference in ADR between patients who never smoked and smokers with a 20 pack year exposure was 8.8% (p <0.0001). The highest rate for smokers with 20 or more pack years was among males (35.8% (34.0% - 37.7%)). The ADR for screening colonoscopies performed in obese participants (26.8% (25.8% - 27.9%)) was significantly higher than that for screening colonoscopies performed in non-obese adults (21.8% (21.1% - 22.5%); p <0.0001), with similar results found for sex specific rates.

The overall screening SDR (95% CI) was 9.6% (9.2% - 10.0%; Table 2). The SDR was higher among males (11.0% (10.4% - 11.7%)) than among females (8.5% (8.0% - 9.0%); p <0.0001). Similar to the ADR results, significant increases in overall (p<0.0001) and sex specific SDR were found among smokers (males: p<0.0001; females: p<0.0001) and obese participants (p<0.0001).

Table 3 presents the results for sex-age specific ADR (95% CI) and SDR (95% CI) for each patient risk group. ADR for males 60 years or older (32.8 % (31.3% - 34.4%)) was elevated as compared to that in younger males (28.7% (27.5% - 29.8%)). Older females (60+ years) also had a higher ADR (20.4% (19.3% - 21.6%) than younger females (17.1% (16.3% - 18.0%)). The highest ADRs (95% CI) were observed in older men with 20 pack years exposure (36.3% (33.5% - 39.2%)) and older obese men (37.1% (34.2% - 40.0%)) The highest SDRs (95% CI) were also found among males aged 60 years or older who smoked more than 20 pack years (15.2% (13.4% - 17.2%)) and older obese males (13.1% (11.1% - 15.2%)).

Discussion

In our study, NHCR participants who had a 20-pack year or greater history of smoking had a significantly higher ADR as compared to those individuals with lower smoking exposure or those adults who never smoked. We observed a higher ADR for obese participants as compared to non-obese adults. Of note, we found the ADR difference between the high smoking exposure group and the adults who never smoked was 8.8%. ADR differences among men and women non-smokers and smokers were even more pronounced and reached nearly 10% among the younger age groups (50-59 years old); a result which is similar to the difference found in our study for the overall ADR between men and women[5]. Additionally, we found ADRs for some of the subgroups were notably higher than the current recommended benchmarks (*ACG/ASGE recommendations[5]*). For example, the ADR for obese males older than 60 years of age was 37.1%. However, despite having a significant proportion (47%) of current or former smokers, our registry's overall ADR was 23.6%, which is consistent with known screening population benchmarks. One interesting finding is that the ADR increased by 5.9% for the men in the 50-59 year age group to the 60 year group, but it increased by less than 1% for heavy smokers. Similar findings were observed in women, an increase of 4.4% for the younger group and 0.6% for the older group. These

findings might suggest that perhaps smoking accelerates production of adenomas so that smokers develop a peak adenoma level at a younger age.

A recent joint statement from the ACG/ASGE recommends that endoscopists achieve an overall ADR of 25% in screening colonoscopies, 20% for women and 30% for men[5]. It is unclear whether and how the ADR should be adjusted for the presence of risk factors other than sex. Studies have examined the association between ADR and family history of colorectal neoplasia[25], sex,[6] and exam related factors.[26-29] One study found a small change in ADR when adjusting for demographics such as patient race[30]. However, few studies have investigated ADRs in adults with other risk factors that are associated with an increased risk of CRC. Based on many studies[9,10,12,31], recent ACG CRC Screening Guidelines identify adults who are obese or have smoked more than 20 pack years as being at a higher risk for colorectal neoplasia than average-risk individuals without these risk factors[7]. In addition, smoking and obesity were also highlighted by the recent ACG/ASGE joint paper[5] on quality indicators for colonoscopy as factors that influence adenoma prevalence. However, there are no current recommendations to adjust ADR benchmarks for these risk factors[5].

To the best of our knowledge, our study is the first analysis to present adenoma and serrated polyp detection rates for screening colonoscopies in individuals stratified by additional risk factors of smoking and obesity. As highlighted by the fact that almost 50% of people within the statewide NHCR database have a smoking history, this distinction may have wide applicability. ADR is the primary colonoscopy quality measure and higher detection rates have been shown to be inversely correlated with interval cancer risk[3]. Recent data suggest that an ADR higher than the currently recommended 25% may be required to ensure maximal protection from interval cancer[4]. Setting appropriate ADR benchmarks is critical to optimizing quality of colonoscopy. Therefore, whether and/or when to adjust ADR benchmarks for higher risk populations merits investigation.

Our study findings suggest that endoscopists should be cognizant of the prevalence of these risk factors in their screening populations. The increasing use of electronic medical records facilitates the assessment of smoking and obesity within the population of patients for a given endoscopist or a given group practice. For example, the software that is used for Clinical Outcomes Research Initiative (CORI) captures smoking history as well as height and weight[32]. This information would allow stratification of ADR benchmarks within the large group of screening patients, informing optimal care. As with sex, endoscopists could stratify their ADR into smokers versus non-smokers and obese versus non-obese adults. Based on our data, the recommended ADR benchmark goal may more appropriately be at least 35% for male heavy smokers. A screening study of over 3000 veterans observed an adenoma detection rate of 37.5%[33]. In this cohort of male veterans, nearly three quarters of all men were smokers and nearly half had a 25 pack-year of more smoking exposure[34]. Thus, an endoscopist in a Veterans Affairs hospital, where many patients are male and have a heavy smoking history, might need to achieve a higher benchmark than the current recommendation of 30%, in order to ensure patients adequate protection from CRC[34].

However, it should be noted that despite the high ADR in smokers with a 20 pack year exposure as well as the high prevalence of all smokers in our sample, the overall ADR was

23.6%, which is not notably different from established benchmarks for a typical screening population. Furthermore, the 50% prevalence of adults in the NHCR who had a smoking exposure, past or current, has also been observed in other similar screening populations[11]. Therefore, while adjustment for smoking or obesity may be needed in a population with a particularly high prevalence of these risk factors, especially if many individuals have a 20 pack year or greater exposure, stratification may not be necessary in typical screening populations.

Given the association between the serrated pathway and CRC as well as the variation in endoscopist serrated polyp detection rates, SDR is another metric that has been proposed as a potential colonoscopy quality measure[15,16,26]. In our study, we found a significant difference in SDR between smokers with a 20 pack year history and those individuals who never smoked (12.0% versus 8.2%), which is similar to the ADR findings among the smoking groups. These results are not surprising given previous studies demonstrating a link between obesity, smoking and serrated histology[35,36]. As with ADR, our data suggest that once SDR benchmarks are clearly established, in order to optimize quality, those benchmarks may require further investigation to determine whether adjustment for obesity and smoking is needed. It is noteworthy that unlike ADR, SDR for each sex was not higher among older individuals. This finding supports previously published data demonstrating that while risk for conventional adenomas increases dramatically with age, the risk for serrated lesions is not increased in older adults[24,34].

A limitation of this analysis is the presence of minimal racial diversity in NH. While this may limit generalizability, the racial homogeneity of the population may have reduced the possibility of confounding variables related to race, thus allowing us to study the specific exposure variables for a defined population. Further studies will be needed to clarify the impact of smoking and obesity on ADR and SDR in other populations. We also acknowledge that BMI was self-reported in our sample. With regards to the feasibility of measuring ADR for these high risk adults in practice, we acknowledge that not all electronic health records (EHRs) or endoscopy software capture smoking exposure and thus it may not be feasible to know the prevalence of heavy smokers in all practices. However, clinical practice would suggest that smoking may be more frequently assessed in health centers serving populations where there is a high prevalence of this important risk factor.

There are several strengths in our analysis. Our main exposure variables, obesity and smoking, have been identified in several models as predicting the presence of advanced adenomas in large populations[37,38]. In addition, our findings were consistent when the results were stratified by two other powerful adenoma predictors, age and sex. The large database of the NHCR, with nearly 22,000 screening colonoscopies included in this analysis, provided excellent power to examine the impact of obesity and smoking. The screening colonoscopies were performed by 77 endoscopists, practicing at 20 diverse facilities including community and academic practices, both urban and rural, thereby increasing the generalizability of the results. Furthermore, the detailed exam and specimen level data of the NHCR allowed this analysis to exclude incomplete exams and those with poor bowel preparation. Excluded exams within the screening group (i.e., poor prep and incomplete colonoscopies) represented only a small fraction of that group, limiting the potential for bias

in the determination of a screening ADR in that population. Finally, comprehensive pathology capture with matching at the individual polyp level[19] enabled accurate calculation of ADR and SDR.

In summary, our investigation demonstrates that ADRs in male and female smokers and obese males are higher than non-smokers and non-obese individuals in our population, and also higher than the recommended benchmark ADRs for screening populations without these risk factors. Given the importance of achieving adequate ADR in ensuring protection from interval cancers[4], adjustment in ADR benchmarks to appropriately account for these factors may be indicated in populations with particularly high prevalence of these risk factors. For example, a population in which 50% of the screening population has a *20 pack year or greater* smoking exposure, such as those observed in VA facilities, might require a higher ADR to ensure adequate protection from interval cancer (35% for men and 25% for women). While 47% of our sample had any smoking exposure, only half of that group (25% of the screening population) had a significant exposure of 20 pack years. The overall ADR for the entire sample was not higher than that of a typical screening population. Therefore, for most typical screening populations, no adjustment may be necessary since ADR outcomes fall within the range of current benchmarks. However, endoscopists should be aware of the prevalence of these risk factors, especially of a high prevalence of heavy smokers in their screening practice. Studies in other populations are also needed to support optimal benchmark goals.

Acknowledgments

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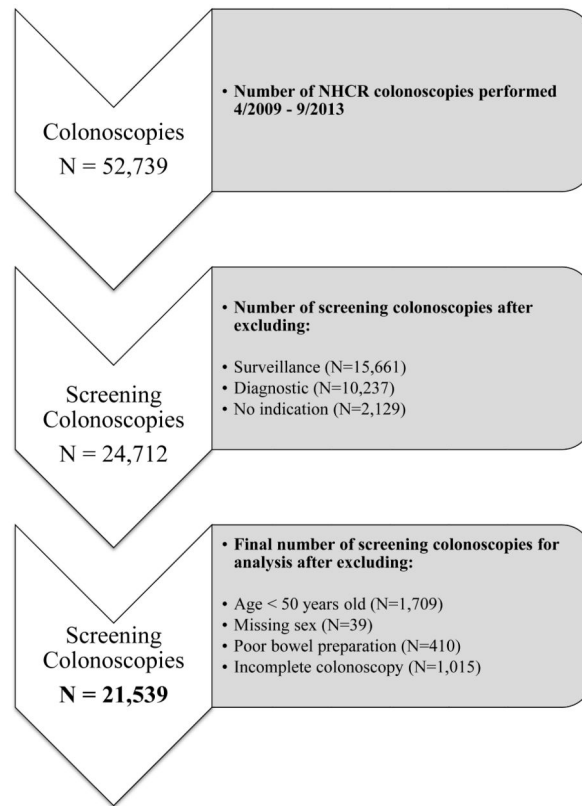
Figure 1.
Flow diagram for study analysis of the New Hampshire Colonoscopy Registry

Table 1

Overall and sex specific adenoma detection rates and 95% confidence intervals for patient risk factors among NHCR screening colonoscopies (4/6/2009 -9/13/2013)

Risk Factors[1]		All Colonoscopies N=21,539		Male N=9,491 (44%)	Female N=12,048 (56%)
		Adenoma N	Rate, % (95% CI)	Rate, % (95% CI)	Rate, % (95% CI)
All Patients		5,083	23.6 (23.0 - 24.2)	30.2 (29.3 - 31.2)	18.4 (17.7 - 19.1)
Smoking	Never (N=10,921)	2,294	21.0 (20.2 - 21.8)	27.5 (26.2 - 28.8)	16.0 (15.1 - 17.0)
	< 20 Pack Years (N=4,254)	940	22.1 (20.9 - 23.4)	29.2 (27.1 - 31.4)	17.3 (15.8 - 18.8)
	20 Pack Years (N=5,423)	1,614	29.8 (28.5 - 31.0)	35.8 (34.0 - 37.7)	24.2 (22.7 - 25.9)
BMI	< 30 (N=13,778)	3,002	21.8 (21.1 - 22.5)	28.1 (27.0 - 29.3)	17.1 (16.2 - 17.9)
	30 (Obese) (N=7,036)	1,887	26.8 (25.8 - 27.9)	33.7 (32.1 - 35.3)	20.7 (19.4 - 22.0)

[1] Missing (N): Smoking (941); BMI (725).

Table 2

Overall and sex specific serrated detection rates and 95% confidence intervals for patient risk factors among NHCR screening colonoscopies (4/6/2009 -9/13/2013)

Risk Factors[1]		All Colonoscopies N=21,539		Male N=9,491 (44%)	Female N=12,048 (56%)
		Serrated N	Rate, % (95% CI)	Rate, % (95% CI)	Rate, % (95% CI)
All Patients		2,071	9.6 (9.2 - 10.0)	11.0 (10.4 - 11.7)	8.5 (8.0 - 9.0)
Smoking	Never (N=10,921)	905	8.2 (7.8 - 8.8)	9.7 (8.9 - 10.6)	7.2 (6.6 - 7.9)
	< 20 Pack Years (N=4,254)	410	9.6 (8.8 - 10.6)	11.0 (9.5 - 12.5)	8.7 (7.7 - 9.9)
	20 Pack Years (N=5,423)	652	12.0 (11.2 - 12.9)	13.2 (12.0 - 14.6)	10.9 (9.8 - 12.1)
BMI	< 30 (N=13,778)	1,214	8.8 (8.3 - 9.3)	10.1 (9.4 - 10.9)	7.8 (7.3 - 8.4)
	30 (Obese) (N=7,036)	779	11.1 (10.3 - 11.8)	12.6 (11.5 - 13.7)	9.7 (8.8 - 10.7)

[1] Missing (N): Smoking (941); BMI (725).

Table 3

Sex-age specific adenoma and serrated detection rates and 95% confidence intervals for patient risk factors among NHCR screening colonoscopies (4/6/2009 -9/13/2013)

Risk Factors[1]		Male N = 9,491 (44%)		Female N = 12,048 (56%)	
		50-59 years N = 5,936 (62%)	60 years N = 3,555 (38%)	50-59 years N = 7,457 (62%)	60 years N = 4,591 (38%)
		Rate, % (95% CI)	Rate, % (95% CI)	Rate, % (95% CI)	Rate, % (95% CI)
All Patients	ADR	28.7 (27.5 - 29.8)	32.8 (31.3 - 34.4)	17.1 (16.3 - 18.0)	20.4 (19.3 - 21.6)
	SDR	11.4 (10.6 - 12.3)	10.3 (9.3 - 11.4)	8.6 (8.0 - 9.3)	8.2 (7.5 - 9.1)
Smoking	Never ADR	25.7 (24.2 - 27.2)	31.6 (29.2 - 34.0)	14.4 (13.3 - 15.6)	18.8 (17.2 - 20.5)
	SDR	10.0 (9.0 - 11.1)	9.0 (7.6 - 10.6)	7.1 (6.3 - 7.9)	7.5 (6.4 - 8.6)
	< 20 Pack Years ADR	28.4 (25.6 - 31.4)	30.2 (26.9 - 33.6)	16.2 (14.4 - 18.1)	19.2 (16.7 - 21.9)
	SDR	10.5 (8.6 - 12.6)	11.5 (9.4 - 14.0)	9.6 (8.2 - 11.2)	7.3 (5.7 - 9.1)
	20 Pack Years ADR	35.4 (32.9 - 37.9)	36.3 (33.5 - 39.2)	24.0 (21.9 - 26.1)	24.6 (22.2 - 27.2)
	SDR	10.7 (9.0 - 12.7)	15.2 (13.4 - 17.2)	11.1 (9.6 - 12.7)	10.7 (9.0 - 12.6)
BMI	< 30 ADR	26.4 (24.9 - 27.8)	30.8 (29.0 - 32.7)	15.8 (14.8 - 16.9)	19.1 (17.7 - 20.5)
	SDR	10.8 (9.8 - 11.9)	9.1 (8.0 - 10.3)	8.3 (7.5 - 9.1)	7.2 (6.3 - 8.1)
	30 (Obese) ADR	32.0 (30.1 - 34.0)	37.1 (34.2 - 40.0)	19.3 (17.7 - 20.9)	23.1 (20.9 - 25.5)
	SDR	12.3 (11.0 - 13.8)	13.1 (11.1 - 15.2)	9.3 (8.2 - 10.6)	10.4 (8.9 - 12.2)

[1]Missing (N): Smoking (941); BMI (725).