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Alcohol drinking, tobacco smoking and anthropometric characteristics as risk factors for thyroid cancer: A countrywide case-control study in New Caledonia

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Abbreviations

BMI: body mass index

CI: confidence interval

OR: odds ratio

TSH: thyroid-stimulating hormone

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Running head: Risk factors of thyroid cancer in New Caledonia

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ABSTRACT

Exceptionally high incidence rates of thyroid cancer are observed in New Caledonia, particularly in Melanesian women. To investigate further the etiology of thyroid cancer, and to clarify the reasons of this elevated incidence, the authors conducted a countrywide population-based case-control study in this multiethnic population. The study included 332 cases with histologically verified papillary or follicular carcinoma (293 women and 39 men) diagnosed in 1993-99 and 412 population controls (354 women and 58 men) frequency matched by gender and five-year age group. Thyroid cancer was negatively associated with tobacco smoking and alcohol drinking but no inverse dose-response relationship was observed. Height was positively associated with thyroid cancer particularly in men. Strong positive associations with weight and body mass index (BMI) were observed in Melanesian women above 50 years of age, with an odds ratio of 4.0 (95% confidence interval: 1.2,13.5) for a BMI above 35 kg/m^2 compared to normal-weight women and there was a clear dose-response trend. This study clarifies the role of overweight for thyroid cancer in post-menopausal women. Because of the high prevalence of obesity among Melanesian women of New Caledonia, this finding may explain in part the exceptionally elevated incidence of thyroid cancer in this group.

Keywords: alcohol drinking; body height; body mass index; body weight; case-control study; New Caledonia; smoking; thyroid neoplasms

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Thyroid cancer represents about 1 percent of all cancers worldwide but it is the most important endocrine malignancy (1). In 1993-1997 the age-standardized incidence rate per 100,000 ranged from 3 to 8 in women and from 1 to 3 in men in most countries (2), but incidence rates of about 20 among women have been reported in Iceland, for Filipinos in Hawaii, or in French Polynesia (2, 3). In recent years the incidence of thyroid cancer has increased sharply in many geographic areas, particularly for papillary carcinomas (4-9). With the exception of thyroid cancer in children in areas with high radioactive fallout from the Chernobyl accident (10), most of this increase is attributed to improved screening of thyroid tumors, as can be assessed from the increasing proportion of microcarcinomas (11). We have recently reported elevated incidence rates for thyroid cancer in New Caledonia, a French overseas territory in South Pacific. This country has approximately 200,000 inhabitants of whom 45 percent are native Melanesians, 35 percent are of European origin, and 20 percent are of various ethnic groups, mainly Polynesian or Asian. In 1995-1999 incidence rates among women were as high as 60 per 100,000, and 120 per 100,000 for women of Melanesian origin (9). Enhanced detection of thyroid nodules starting in 1995 probably accounts for the increase in incidence of thyroid cancer, but the rates for this cancer have been outstandingly elevated in this population since at least 1985 (9, 12). The reasons for the elevated incidence are currently unknown, but nuclear tests carried out in French Polynesia do not constitute an explanation *a priori,* this territory being located more than 4500 km away.

To investigate further risk factors for thyroid cancer and to clarify the reasons of the exceptionally high incidence in New Caledonia, we conducted a countrywide population-based case-control study. Besides ionizing radiations, the only well-established cause of thyroid cancer, many other risk factors are suspected to play a role in the etiology of the disease (13). Reproductive factors such as irregular menstruations, miscarriages and number of full term pregnancies were reported previously to be associated with thyroid cancer (14). In

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the present paper we focus on alcohol and tobacco consumption and on anthropometric characteristics.

In most epidemiological studies carried out to date, findings are compatible with a moderate inverse association of thyroid cancer with tobacco smoking (15-24). In a pooled analysis of 14 case-control studies published before 1997 (25), current cigarette smoking was significantly associated with a moderate reduction in risk of thyroid cancer. There was also some evidence of a decreasing trend of thyroid cancer risk with smoking intensity and duration (20, 25), suggesting a causal relationship between tobacco smoking and thyroid cancer. Additionally, inverse association of thyroid cancer with alcohol drinking was suggested in some studies. However, in the pooled analysis including 10 case-control studies with data on wine and beer consumption, the decreasing trend of thyroid cancer with total alcohol intake was not significant after adjustment for current smoking (25).

Because thyroid function is linked to the growth and development, height and weight have been seen as possible indicators of thyroid cancer risk. In a pooled analysis of 12 case-control studies, both men and women with height in the upper tertile had moderately increased odds ratios (OR) for thyroid cancer as compared to men and women in the lower tertile (26). Similarly, a cohort study from Norway reported a moderate association between height and thyroid cancer (27). Overweight has been inconsistently associated with thyroid cancer in several studies (15, 28-30), with a pooled odds ratio estimate of 1.2 [95 percent confidence interval (CI): 1.0, 1.4] for the women in the upper tertile of body mass index (BMI) (26). In the Norwegian cohort study (27), a moderately increased relative risk of 1.29 for thyroid cancer was reported for obese women with BMI equal to or greater than 30.0 kg/m^2.

Our study in New Caledonia permitted to investigate further these factors in a multiethnic population with various lifestyle and genetic background.

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MATERIAL AND METHODS

Case selection

Cases were patients with papillary or follicular thyroid cancer diagnosed between January 1, 1993, and December 31, 1999, who had been living in New Caledonia for at least 5 years at the time of diagnosis. Thyroid cancer patients were identified from the two pathology laboratories of New Caledonia, as reported previously (9). Cases were also sought in the cancer registry of New Caledonia, but no additional cancer case was identified, leading to 369 incident cases eligible to the study. All pathology reports were reviewed to determine the histological type of the tumor as well as the number and the diameter of the cancerous nodules in the thyroid gland. When information was missing, the original histological slides were reviewed by the pathologist.

Although the data collection started in 1998, the good prognosis of the disease permitted to contact the patients diagnosed in 1993-1997 for inclusion in the study. Cases diagnosed in 1998 and 1999 were recruited prospectively. Of the 369 eligible cases of thyroid cancer, 37 (10 percent) could not be interviewed because the subject was dead (n=21), refused to participate (n=10), could not be contacted (n=5) or was too ill (n=1).

Control selection

Controls were randomly selected from recently updated electoral rolls available in 1998 that included the name, sex, address, and date of birth of all New Caledonia residents aged 18 years or older. The controls were frequency-matched to the cases by gender and 5-year age group. To achieve density sampling of the source population, seven control groups were selected at random among New Caledonia residents for each year of the study period, and were assigned a reference year ranging from 1993 to 1999. Each control group was frequency-matched to the group of cases with a thyroid cancer diagnosed during the corresponding year of the study period. Only variables determined at or before the year of

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diagnosis for the cases or the year of reference for the controls were considered in the analyses. Subjects were not eligible as controls if they had not been living in New Caledonia for at least 5 years as of the date of reference or if they had had a cancer of the thyroid before that date.

Of 473 eligible controls, 61 (13 percent) could not be interviewed because they were dead (n=13), refused to participate (n=21), could not be contacted (n=24), were too ill (n=2) or for another reason (n=1).

Data collection

All eligible cases and controls were contacted for a face to face interview, and data were obtained using a structured questionnaire after the subject had signed informed consent. In the present paper, we focus on anthropometric factors, alcohol drinking, and tobacco smoking. Subjects who had quitted smoking for at least one year at the reference year were classified as ex-smokers. Pack-years of tobacco smoking were calculated from the total number of years of tobacco smoking and from the number of cigarettes smoked per day. In these calculations we assumed that one pipe = one cigarillo = 2 cigarettes (2 women and 7 men were pipe smokers; 1 man smoked cigarillo). Alcohol drinking was assessed in the questionnaire as the number of glasses per week separately for each type of beverage (beer, wine, aperitif, and liqueur). Because the ethanol content is approximately the same for an ordinary glass of any alcoholic beverage, the total number of drinks per week was used as an indicator of total alcohol intake.

Height and weight at the year of reference were used to calculate body mass index in kilograms per square meter (kg/m^2). Categorization of the BMI followed the definition of the World Health Organization (31) that considers underweight for BMI < 18.50 kg/m^2, normal weight for BMI=18.50-24.99 kg/m^2, pre-obesity for BMI=25.00-29.99 kg/m^2, moderate obesity for BMI=30-34.99 kg/m^2 and severe obesity for BMI ≥35 kg/m^2.

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Statistical analysis

The analyses were conducted for men and women separately because risk factors may differ by sex. Unconditional logistic regression (32) was performed using SAS software version 9.1. All odds ratios were adjusted for age (five-year age groups), and for ethnic group in the analyses with all subjects combined. Further adjustments for the year of reference/diagnosis did not modify the results and are not shown. Tests for trend were conducted by fitting models using a quantitative variable equal to the median value of the exposure classes. Stratification by ethnic group was conducted in women only, because the number of men was too small for a meaningful analysis. Women were also stratified by age group (< 50 years; ≥ 50 years), which was used as a proxy for menopausal status. Stratification by menopausal status was also performed after excluding peri-menopausal women, but the results were unchanged and are not shown. Stratification by menopausal status was also carried out after excluding a few women with unknown status for menopause, but the results were similar and are not shown. Non ordinal polytomous logistic regression (33) was carried out by dividing the cases into 2 groups according to the size of the thyroid carcinoma (≤ 10 mm, > 10 mm). Odds ratios for alcohol drinking and tobacco smoking were calculated from a single multivariate model where each variable was adjusted for the other. Odds ratios for weight and body mass index were adjusted for miscarriage, irregular menstruations, and number of full-term pregnancies as these variables may act as confounders (14).

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RESULTS

Approximately 85 percent of the thyroid cancer cases were of the papillary type, 55 percent of them having a diameter below 10 mm (table 1). Because of the frequency-matched design of the study, the distribution by age group was similar in cases and in controls. Proportionally more cases than controls were of Melanesian origin, reflecting the higher incidence rate in this group. Among Melanesians, more cases than controls were living in the Loyalty Islands, as expected because of the higher incidence in this province (9).

Tobacco smoking and alcohol drinking

Smoking status was not associated with thyroid cancer (table 2). The odds ratios for tobacco smoking were lower than one in the 10-20 pack-years category and at the limit of statistical significance in women, but there was no dose-response relationship. No association with age at start of smoking, smoking duration, or daily tobacco consumption was observed (results not shown). The odds ratios for alcohol drinking were below 1, and as low as 0.45 for women declaring 1 to 10 drinks per week, but the tests for trend were not statistically significant (table 2). Analyses by type of alcoholic beverage, stratification by ethnic group, province, or size of carcinoma did not alter these findings (not shown).

Anthropometric characteristics

Among women, odds ratios in height categories above 160 cm, as compared to smaller height, were about 1.3. There was a significant trend of thyroid cancer risk with weight ($p<0.01$), and the odds ratio for women weighing 90 kg or more, as compared to women below 60 kg, was 2.3. Results for BMI indicated that women with moderate (BMI 30-34.99) or severe (BMI $\geq$ 35) obesity had a two-fold increased risk as compared to women in the normal range (BMI 18.5-24.99), and a linear trend with BMI was apparent (table 2).

Among men, height categories in the range 170-174 cm and 175-179 cm were associated with odds ratios of about 4, but no dose-response trend was apparent as the odds

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ratio decreased to 1.66 in men taller than 180 cm (table 2). No association with weight or body mass index was seen in men.

Odds ratios for anthropometric characteristics in women are shown by ethnic group in table 3. Height was clearly associated with thyroid cancer in European women only. Odds ratios for weight and body mass index were quite consistent across all ethnic groups, and the test for trend was statistically significant for Melanesian women. It can also be noted from table 3 that the prevalence of obesity (BMI > 30 kg/m^2) was higher among Melanesian (26 percent) than among European (17 percent) control women.

Results of the stratified analysis by age group (<50 years; ≥50 years) are shown in table 4 for Melanesian women. In women below 50 years of age, no association was apparent with body size variables. Conversely, in women 50 years of age and older, the odds ratios for weight and body mass index increased sharply, ranging between 3 to 4 for body mass index above 30 kg/m^2, and the tests for trend were statistically significant. Similar results were observed in stratified analyses combining women of all ethnic groups (not shown).

We finally analyzed the effects of anthropometric characteristics by size of the carcinomas in ≥ 50-years-old Melanesian women. Assuming that microcarcinomas (≤10 mm) are most likely detected during systematic screening of thyroid cancer, this analysis was conducted to see if the associations with weight and body mass index might be related to higher detection rate of thyroid nodules in overweighed women than in normal weight women. This hypothesis is not supported by results in table 5 where the odds ratios for weight and body mass index do not differ according to the size of carcinoma.

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DISCUSSION

We found a strong positive association between thyroid cancer and weight or body mass index in Melanesian women over 50 years of age. No such association was apparent in men or in younger women. There was also some indication of an association with height, particularly in men. There was no evidence of an association with tobacco smoking. Odds ratios for alcohol drinking were all below unity, although most of them did not reach statistical significance.

Strengths and limits

This study has important strengths including the high incidence of thyroid cancer in the study population, the population-based design with virtually exhaustive identification of thyroid cancer cases, and a high participation rate among cases and population controls. A careful review of all pathological reports and slides in the study constitutes another important feature. It permitted to classify thyroid tumors according to the size of carcinoma and to assess the effects of a possible detection bias due to enhanced diagnoses of thyroid cancers. To our knowledge, no previous study on thyroid cancer risk factors has considered the size of the carcinoma in reporting results, as this information is often not available.

This study also has some limitations. Small numbers did not permit detailed analyses to be carried out in subgroups such as men and non-Melanesian women. It is also possible that tobacco and alcohol consumptions were underestimated, and that self-reported measures of body size were imprecise. These problems most likely entailed non differential misclassification. Finally, we collected data on weight at different periods of life, but this information was often missing or unreliable and could not be used in the analyses.

Tobacco

In most previous case-control studies, an inverse association between tobacco smoking and thyroid cancer has been reported (16, 17, 20, 22, 23). In a pooled analysis of 14 case-

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control studies, the odds ratio for 40 pack-years of tobacco smoking as compared to never smoking was 0.6 (25). This result was confirmed in a recent large case-control study where a highly significant inverse dose-response relationship was reported (20). Conversely, no association of tobacco smoking with thyroid cancer was found in two prospective cohort studies of men and women in the San Francisco bay area (18) and of Canadian women (24), but the results were based on relatively small numbers of thyroid cancer patients. In the present study, a U-shaped pattern was observed, with decreased odds ratios in the intermediate category of 10-20 pack-years for men and women. The absence of a clear inverse association in our data could be explained if the number of cigarettes smoked per day, as declared by the subjects, was underestimated particularly by heavier smokers. If the effect of tobacco smoking is real, the anti-estrogenic properties of tobacco smoke and the decrease in thyroid-stimulating hormone (TSH) levels related to tobacco are possible biological mechanisms (34, 35). Interestingly the risk of thyroid cancer among ex-smokers increased with the duration since cessation of smoking in one epidemiological study (17), suggesting that the effects of tobacco smoke could be of relatively short duration, and could act during late stages of tumor development. No such pattern was observed in our data (results not shown).

Alcohol

Negative associations between alcohol drinking and thyroid cancer have also been reported in some studies (15, 17, 19, 36), but the results have been inconsistent (16, 37). In the pooled analysis including 10 case-control studies that collected data on wine and beer consumption, there was a significant trend of decreasing thyroid cancer risk with the number of drinks per week, which disappeared after adjustment for current smoking (25). Small alcohol intake are declared in our study. Hower, it provides some support for a negative association between alcohol drinking and thyroid cancer that was not confounded by tobacco

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smoking, although odds ratios under 0.5 were observed in intermediate alcohol drinking categories among women. A decreased risk of thyroid cancer might be related to the reduction of thyroid cell proliferation due to altered TSH response to TSH-releasing hormone that has been consistently reported among alcoholics (38).

Height

Height was positively associated with thyroid cancer in men and in European but not Melanesian women. In a pooled analysis of anthropometric factors in thyroid cancer including 11 case-control studies from the USA (15, 16, 39, 40), Europe (41-46), and Asia (29), as well as one unpublished case-control study from Japan (26), height in the upper tertile was associated with significantly increased odds ratios of 1.5 in men and of 1.2 in women. A large cohort study from Norway reported a moderate but statistically significant association of thyroid cancer with height in both sexes (27). Our data tend to confirm these findings, although not consistently across all ethnic groups. Correlate of adult height such as dietary factors that also influence thyroid function and thyroid cancer might represent a possible explanation for this association (26).

Weight and body mass index

The association between thyroid cancer and weight or body mass index at the time of diagnosis was apparent in Melanesian women over 50 years of age. Weight was associated with increased risk of thyroid cancer in European and other ethnic group women, but no significant trend was observed. No association with weight or body mass index was detected among men.

In the pooled analysis of case-control studies, the subjects were classified in low, intermediate and high BMI categories using study-specific tertiles (26). Women in the upper tertile had a pooled odds ratio of 1.2 only (95 percent CI: 1.0, 1.4) as compared to women in the lower tertile (26). Because the tertiles were based on study-specific distributions, the

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pooled odds ratio could not be linked to a well-defined range of BMI values, making difficult a comparison between studies. The comparatively high odds ratios for BMI observed in the present study may be explained by higher BMI values among Melanesian women than in other study populations. In particular, we were able to define a BMI category of 35 kg/m^2 or more in our study, which is coherent with the high prevalence of obesity described in New Caledonia (47).

The increased risks of thyroid cancer with weight and body mass index described in the present study for women older than 50 years, were consistent with the study from Hawaii, that reported an association between thyroid cancer and weight or body mass index among postmenopausal women (30). In the pooled analysis, it is stated that the association with BMI was of similar magnitude in post- and pre-menopausal women (26), but the detailed figures were not shown. In a large cohort study carried out in Norway, a moderately increased relative risk of about 1.3 for women with a body mass index of 30 kg/m^2 or more was observed for both groups of women below or above the age of 50 years (27). In this cohort, weight was measured at the time of entry into the cohort, on average 15 years before cancer diagnosis. This study may have overlooked recent weight as the possible variable of etiologic importance, particularly for older women if weight gain occurring at the time of menopause was not taken into account. In fact, experimental data suggest that estrogens influence late stages of thyroid carcinogenesis by promoting thyroid tumor growth (48). Because adipose tissues are the main site of estrogen production after menopause, our finding of a strong association between thyroid cancer and BMI in women above 50 years of age, mainly post-menopausal, has some biological support.

It has been suspected that the association between weight or body mass index and thyroid cancer may be due to more frequent examination of the thyroid gland in overweight women (26). Because enhanced detection of thyroid cancer leads to more frequent diagnoses

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of small size carcinomas as demonstrated in several time trend analyses of thyroid cancer incidence in New Caledonia (9) and France {colonna2007}, we have analyzed this association according to the size of the cancerous nodule. We have shown that the association between weight or body mass index and thyroid cancer in older Melanesian women is similar whatever the size of the carcinoma, indicating that detection bias is not a likely explanation for our findings.

Conclusion

We have shown a clear positive association between weight or body mass index and thyroid cancer in women aged 50 years or more. The high prevalence of overweight among older Melanesian women could explain in part the exceptionally high incidence of thyroid cancer, as it was estimated that about xx% of the cases in this group were attributable to a BMI above 30 kg/m2. The strong association between BMI and thyroid cancer that was not observed in other previously studied populations, may be related to possible interactions between BMI and as yet unmeasured genetic or environmental factors specific to Melanesian women of New Caledonia.

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TABLE 1. Sociodemographic characteristics of thyroid cancer cases and controls by gender, New Caledonia, 1993-1999

	Women						**Men**					
	Cases N=293		**Controls N=354**		**OR*†**	**95% CI**	**Cases N=39**		**Controls N=58**		**OR**	**95% CI**
	n	**%**	**n**	**%**		***(p-value‡)***	**n**	**%**	**n**	**%**		
Histology												
Papillary	255	87.0					33	84.6				
≤ 10 mm	139	*54.5*					19	*57.6*				
> 10 mm	114	*44.7*					12	*36.4*				
Missing	2	*0.8*					2	*6.1*				
Follicular	38	13.0					6	15.4				
Age (years)												
<25	10	3.4	13	3.7			0	0.0	0	0.0		
25-29	24	8.2	24	6.8			0	0.0	0	0.0		
30-34	34	11.6	42	11.9			1	2.6	1	1.7		
35-39	32	10.9	38	10.7			1	2.6	4	6.9		
40-44	29	9.9	37	10.5			6	15.4	7	12.1		
45-49	36	12.3	32	9.0			5	12.8	6	10.3		
50-54	30	10.2	41	11.6			9	23.1	14	24.1		
55-59	40	13.7	37	10.5			2	5.1	4	6.9		
60-64	24	8.2	44	12.4			9	23.1	13	22.4		
65-69	18	6.1	19	5.4			1	2.6	5	8.6		
≥ 70	16	5.5	27	7.6		*(0.66)*	5	12.8	4	6.9		
Ethnic group												
European	32	10.9	110	31.1	1.00	Reference	10	25.6	23	39.7	1.00	Reference
Melanesian	220	75.1	169	47.7	4.34	2.79, 6.77	24	61.5	20	34.5	3.21	1.08, 9.51
Other	41	14.0	75	21.2	1.77	1.01, 3.07	5	12.8	15	25.9	0.94	0.24, 3.67
Province (Melanesians only)												
South	136	46.4	241	68.1	1.00	Reference	19	48.7	45	77.6	1.00	Reference
North	65	22.2	60	17.0	1.33	0.79, 2.24	10	25.6	9	15.5	2.65	0.57, 12.30
Islands	92	31.4	53	15.0	1.91	1.17, 3.12	10	25.6	4	6.9	5.07	1.03, 25.08

[*] OR, odds ratio; CI, confidence interval.
[†] Adjusted for age.
[‡] p-value of chi-square test.

TABLE 2. Odds ratios of thyroid cancer for tobacco smoking, alcohol drinking, and anthropometric characteristics, New Caledonia, 1993-1999

	Women						Men				
	Ca* N=293	Co N=354	OR	95% CI	*p-trend*†		Ca N=39	Co N=58	OR	95% CI	*p-trend*
Smoking status‡						**Smoking status**					
Never-smoker	180	216	1.00	Reference		Never-smoker	15	20	1.00	Reference	
Former smoker	42	47	1.16	0.70, 1.93		Former smoker	9	17	0.65	0.18, 2.33	
Current smoker	70	91	0.97	0.64, 1.46		Current smoker	15	21	1.02	0.36, 2.93	
Pack-years					*0.55*	**Pack-years**					*0.91*
Never-smoker	180	216	1.00	Reference		Never-smoker	15	20	1.00	Reference	
> 0 – 10	67	67	1.31	0.84, 2.04		> 0 – 10	7	8	1.11	0.28, 4.44	
> 10 – 20	10	25	0.45	0.20, 1.01		> 10 – 20	2	7	0.34	0.05, 2.50	
> 20 – 30	18	22	1.11	0.54, 2.25		> 20 – 30	1	5	0.55	0.05, 6.34	
> 30	11	20	0.90	0.39, 2.07		> 30	12	15	1.01	0.31, 3.25	
N drinks/week§					*0.46*	**N drinks/week**					*0.80*
Never	139	139	1.00	Reference		Never	6	6	1.00	Reference	
0 - < 1	121	136	0.89	0.61, 1.28		0 - < 1	11	20	0.27	0.05, 1.38	
1-5	20	48	0.44	0.24, 0.82		1-5	5	9	0.41	0.07, 2.49	
6-10	7	21	0.46	0.18, 1.21		6-10	5	6	0.73	0.11, 4.91	
> 10	5	8	0.98	0.27, 3.54		> 10	11	17	0.46	0.09, 2.37	
Height# (cm)					*0.34*	**Height** (cm)**					*0.25*
< 160	82	120	1.00	Reference		< 170	10	26	1.00	Reference	
160-164	92	96	1.37	0.88, 2.14		170-174	15	13	4.35	1.23, 15.45	
165-169	72	84	1.25	0.79, 1.99		175-179	10	9	3.88	1.00, 15.02	
≥ 170	42	51	1.30	0.75, 2.25		≥ 180	4	10	1.66	0.36, 7.62	
Weight# (kg)					*<0.01*	**Weight (kg)**					*0.53*
< 60	42	102	1.00	Reference		< 70	9	11	1.00	Reference	
60-69	68	87	1.49	0.88, 2.52		70-79	4	15	0.23	0.04, 1.20	
70-79	63	69	1.61	0.93, 2.78		80-89	14	15	1.86	0.45, 7.74	
80-89	57	45	2.06	1.15, 3.68		≥ 90	9	14	0.91	0.21, 3.84	
≥ 90	51	37	2.26	1.24, 4.13							
BMI (kg/m²)					*<0.01*	**BMI (kg/m²)**					*0.78*
< 18.5	7	15	0.93	0.34, 2.58		< 18.5	0	1			
18.5-24.99	80	150	1.00	Reference		18.5-24.99	11	18	1.00	Reference	
25-29.99	87	96	1.20	0.77, 1.87		25-29.99	15	22	1.03	0.35, 3.07	
30-34.99	64	46	1.95	1.17, 3.25		≥ 30	10	14	1.03	0.29, 3.65	
≥ 35	41	30	1.75	0.98, 3.13							

* Ca, number of cases; Co, number of controls; OR, odds ratio; CI, confidence interval.
† Test for trend using the median of each class as a continuous variable.
‡ Odds ratios and p-trend adjusted for age, ethnic group and number of drinks per week.
§ Odds ratios and p-trend adjusted for age, ethnic group and number of pack-years.
# Odds ratios and p-trend adjusted for age, ethnic group, number of full-term pregnancies, miscarriage and irregular menstruations. BMI, body mass index.
** Odds ratios and p-trend adjusted for age and ethnic group.

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TABLE 3. Odds ratios of thyroid cancer for height, weight and body mass index by ethnic group among women, New Caledonia, 1993-1999

	Melanesian*					**European†**					**Other ethnic groups**				
	Ca‡ N=220	**Co N=169**	**OR**	**95% CI**	***p-trend*§**	**Ca N=32**	**Co N=110**	**OR**	**95% CI**	***p-trend***	**Ca N=41**	**Co N=75**	**OR**	**95% CI**	***p-trend***
Height (cm)					*0.80*					*0.02*					*0.99*
< 160	65	53	1.00	Reference		5	39	1.00	Reference		12	28	1.00	Reference	
160-164	71	48	1.19	0.68, 2.11		10	31	3.08	0.78, 12.20		11	17	1.66	0.50, 5.54	
165-169	50	46	0.80	0.44, 1.44		10	24	4.63	1.17, 18.39		12	14	2.11	0.61, 7.32	
≥ 170	29	20	1.15	0.54, 2.43		7	16	4.93	1.08, 22.45		6	15	0.75	0.18, 3.07	
Weight (kg)					*0.02*					*0.23*					*0.11*
< 60	24	31	1.00	Reference		10	43	1.00	Reference		8	28	1.00	Reference	
60-69	52	41	1.43	0.69, 2.97		8	30	1.46	0.45, 4.77		8	16	2.04	0.51, 8.20	
70-79	47	42	1.47	0.71, 3.05		7	20	1.76	0.44, 7.04		9	7	10.42	1.83, 59.50	
80-89	48	23	2.76	1.25, 6.07		5	10	3.08	0.73, 12.94		4	12	1.15	0.20, 6.51	
≥ 90	37	21	2.15	0.95, 4.87		2	5	1.34	0.16, 11.02		12	11	5.81	1.30, 26.05	
BMI# (kg/m²)					*0.02*					*0.73*					*0.08*
< 18.5	3	4	0.80	0.16, 4.03		2	8	0.61	0.10, 3.82		2	3	3.01	0.29, 31.02	
18.5-24.99	52	53	1.00	Reference		16	58	1.00	Reference		12	39	1.00	Reference	
25-29.99	68	58	1.13	0.64, 1.99		8	23	1.21	0.38, 3.91		11	15	3.51	0.87, 14.19	
30-34.99	50	22	2.21	1.12, 4.34		5	15	1.34	0.37, 4.93		9	9	5.14	1.18, 22.41	
≥ 35	33	19	1.84	0.89, 3.81		1	4	0.56	0.04, 7.78		7	7	4.24	0.81, 22.07	

* Odds ratios and p-trend adjusted for age, province of residence (North, South, Islands), number of full-term pregnancies, miscarriage, irregular menstruations.
† Odds ratios and p-trend adjusted for age, number of full-term pregnancies, miscarriage, irregular menstruations.
‡ Ca, number of cases; Co, number of controls; OR, odds ratio; CI, confidence interval.
§ Test for trend using the median of each class as a continuous variable.
# BMI, body mass index.

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TABLE 4. Odds ratios* of thyroid cancer for height, weight and body mass index by age group in Melanesian women, New Caledonia, 1993-1999

	Women <50-years-old					Women ≥ 50-years-old				
	Ca† N=117	Co N=92	OR	95% CI	*p-trend*‡	Ca N=103	Co N=77	OR	95% CI	*p-trend*
Height (cm)					*0.18*					*0.55*
< 160	31	22	1.00	Reference		34	31	1.00	Reference	
160-164	45	33	0.74	0.33, 1.65		26	15	1.80	0.73, 4.44	
165-169	26	25	0.50	0.20, 1.21		24	21	0.94	0.40, 2.22	
≥ 170	15	12	0.59	0.20, 1.75		14	8	1.68	0.56, 5.06	
Weight (kg)					*0.77*					*<0.01*
< 60	17	18	1.00	Reference		7	13	1.00	Reference	
60-69	29	21	1.05	0.40, 2.74		23	20	3.01	0.80, 11.31	
70-79	27	21	1.13	0.42, 3.04		20	21	2.72	0.75, 9.81	
80-89	23	13	1.99	0.69, 5.69		25	10	5.53	1.40, 21.82	
≥ 90	19	15	0.85	0.29, 2.52		18	6	8.54	1.90, 38.33	
BMI§ (kg/m²)					*0.51*					*<0.01*
< 18.5	2	3	0.67	0.08, 5.37		1	1	0.97	0.05, 20.26	
18.5-24.99	34	30	1.00	Reference		18	23	1.00	Reference	
25-29.99	37	28	1.05	0.48, 2.28		31	30	1.32	0.55, 3.16	
30-34.99	26	14	1.94	0.77, 4.85		24	8	3.37	1.16, 9.80	
≥ 35	16	13	0.90	0.33, 2.41		17	6	4.00	1.18, 13.53	

* Odds ratios and p-trend adjusted for age, province of residence, number of full-term pregnancies, miscarriage, irregular menstruations.
† Ca, number of cases; Co, number of controls; OR, odds ratio; CI, confidence interval.
‡ Test for trend using the median of each class as a continuous variable.
§ BMI, body mass index.

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TABLE 5. Odds ratios[*] of thyroid cancer associated with anthropometric variables, by size of carcinoma, in ≥ 50-years-old Melanesian women, New Caledonia, 1993-1999.

	Size ≤ 10 mm					Size ≤ 10 mm				
	Ca[†] N=55	Co N=77	OR	95% CI	*p-trend*[‡]	Ca N=46	Co N=77	OR	95% CI	*p-trend*
Height (cm)					*0.42*					*0.83*
< 160	16	31	1.00	Reference		17	31	1.00	Reference	
160-164	14	15	1.68	0.56, 5.06		11	15	2.05	0.66, 6.38	
165-169	16	21	1.32	0.47, 3.68		8	21	0.57	0.18, 1.80	
≥ 170	7	8	1.66	0.43, 6.38		7	8	2.00	0.50, 8.08	
Weight (kg)					*<0.01*					*0.05*
< 60	3	13	1.00	Reference		4	13	1.00	Reference	
60-69	12	20	4.55	0.83, 24.90		10	20	2.40	0.42, 13.76	
70-79	10	21	2.89	0.54, 15.34		9	21	2.54	0.49, 13.17	
80-89	13	10	5.37	0.93, 31.12		12	10	7.68	1.29, 45.92	
≥ 90	12	6	15.68	2.41, 102.07		6	6	3.88	0.55, 27.40	
BMI[§] (kg/m²)					*0.02*					*0.06*
< 18.5	0	1				1	1	3.42	0.13, 93.10	
18.5-24.99	11	23	1.00	Reference		6	23	1.00	Reference	
25-29.99	15	30	0.80	0.27, 2.39		16	30	2.55	0.76, 8.60	
30-34.99	15	8	3.17	0.92, 10.95		8	8	3.88	0.91, 16.58	
≥ 35	9	6	3.27	0.79, 13.58		8	6	5.18	1.07, 25.10	

[*] Odds ratios and p-trend adjusted for age, province of residence, number of full-term pregnancies, miscarriage, irregular menstruations.
[†] Ca, number of cases; Co, number of controls; OR, odds ratio; CI, confidence interval.
[‡] Test for trend using the median of each class as a continuous variable.
[§] BMI, body mass index.

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