A.M.-F. Yen^{1*}, H. Lai^{2,3,4}, J.C.-Y. Fann⁵,
S.Y.-H. Chiu⁶, and S.L.-S. Chen¹

¹School of Oral Hygiene, College of Oral Medicine, Taipei Medical University, Taipei, Taiwan; ²QC Dental Clinic, Taipei, Taiwan; ³Department of Dentistry, National Yang-Ming University, Taipei, Taiwan; ⁴School of Dentistry, College of Oral Medicine, Taipei Medical University, Taipei, Taiwan; ⁵Department of Health Industry Management, School of Health Care Management, Kainan University, Taoyuan, Taiwan; and ⁶Department and Graduate Institute of Health Care Management, Chang Gung University, Tao-Yuan, Taiwan; *corresponding author, amyen@tmu.edu.tw

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Relationship between Community Periodontal Index and Fecal Hemoglobin Concentration, an Indicator for Colorectal Neoplasm

ABSTRACT

Periodontal disease and colorectal cancer have inflammatory processes in common. It is therefore worthwhile to investigate whether there is an association between periodontal probing depth and fecal hemoglobin concentration (FHbC), an indicator of colorectal neoplasms, in 40- to 44-year-old Taiwanese. We enrolled a total of 6,214 attendees aged 40 to 44 yr who were participating in a community-based integrated screening program and who received both periodontal and FHbC examinations between 2003 and 2008. A proportional odds logistic regression model was used to estimate the odds ratios of different FHbC levels in treating an increased level of community periodontal index (CPI) measuring periodontal probing depth as ordinary data from 0 to 4. Periodontal probing depth with the order of CPI was in parallel with an increase in the mean values of FHbC: 21.3 ± 156.3 , 26.0 ± 167.7 , 27.2 ± 151.1 , and 39.5 ± 255.7 ng/mL for CPI 0, CPI 1, CPI 2, and CPI 3/4, respectively. The log-FHbC varied across the categories of CPI ($p = .0078$). After adjusting for age, sex, education level, smoking, alcohol intake, exercise, body mass index, and intake of meat and vegetables, subjects with positive fecal immunochemical test results (FHbC ≥ 100 ng/mL) had a 33% higher risk of deteriorating to severe CPI than did those within the normal range of fecal immunochemical test (FHbC < 100 ng/mL) (adjusted odds ratio = 1.33, 95% confidence interval: 1.03-1.73). A positive association was demonstrated between FHbC and periodontal probing depth assessed by CPI among 6,214 Taiwanese aged 40 to 44 yr who participated in a community-based integrated health screening program. These results could have significant implications for early identification of high-risk individuals, as those with deep periodontal pockets should be advised to undergo screening for colorectal cancer at a younger age than commonly recommended.

KEY WORDS: adults, association, inflammatory, periodontal disease, periodontal probing depth, screening.

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INTRODUCTION

The fecal occult blood test has been demonstrated to be an effective screening modality for reducing mortality from colorectal cancer in population-based randomized controlled trials (Mandel *et al.*, 1993, 1999; Hardcastle *et al.*, 1996; Kronborg *et al.*, 1996; Jorgensen *et al.*, 2002). Because of its feasibility and low cost, the fecal occult blood test has been used worldwide. Furthermore, this screening tool has evolved from the conventional chemical

guaiac rehydration method—a qualitative test for dichotomous results (negative and positive)—to the more recently proposed fecal immunochemical test: a quantitative test for numerical measurements of fecal hemoglobin concentration (FHbC) (Yang *et al.*, 2006; Hol *et al.*, 2010). Chen *et al.* (2011) reported that the level of FHbC was associated with the risk of incident colorectal neoplasia in a dose-response manner. Given the molecular epidemiologic finding that the occurrence of colorectal neoplasm was related to inflammatory processes (Groblewska *et al.*, 2008; Hopkins *et al.*, 2012; Huber *et al.*, 2012; Kang *et al.*, 2013), it has been postulated that high levels of FHbC in parallel with high risk for colorectal neoplasia could be indicative of a systematic immunologic response to inflammation (Khosravi *et al.*, 2013). Hence, a high level of FHbC might be associated with subjects who are vulnerable to other common chronic diseases related to inflammatory processes, such as periodontal disease.

Periodontal disease is a common inflammation-induced disease that commences in early age, and it is commonly measured in terms of periodontal probing depth in community survey settings. It is therefore of great interest to elucidate the association between periodontal probing depth and FHbC at an early age. Empirical data for testing this relationship are scarce. A multiple-screening program targeting a constellation of neoplasms and chronic diseases and the commencing of screening at younger ages could provide an opportunity to investigate the association between FHbC and probing depth in young adults. We aimed to use a large group of data from subjects aged 40 to 44 yr who participated in the Keelung Community-based Integrated Screening (KCIS) program to elucidate the relationship between measurements of periodontal probing depth in terms of community periodontal index (CPI) and the level of FHbC, making allowances for other confounding factors.

MATERIALS & METHODS

Community-based Periodontal Examination and Colorectal Cancer Screening

The current study was cross sectional. The subjects were attendees of the KCIS program, which targeted residents aged 20 yr or older in Keelung, the northernmost city in Taiwan. The KCIS program was directed by the city government and implemented by the Keelung City Health Bureau, with subsidization partially from the National Health Insurance and partially from the city government. Details of the implementation of the KCIS program have been published elsewhere (Chen *et al.*, 2004; Chiu *et al.*, 2006). Briefly, the KCIS covered adult health checkups for periodontal probing depth, 3 chronic diseases (hypertension, hyperlipidemia, hyperglycemia), and 5 neoplasias (oral neoplasm, colorectal neoplasm, breast cancer, liver cancer, cervical neoplasm). The screening policies for different screening items—such as age at the start of screening, interscreening intervals, the referral of positive findings, and clinical surveillance of precancerous lesions—were designed in light of evidence-based medical literature. For example, the starting ages for cervical cancer and colorectal cancer were 30 and 40 yr, respectively. The interscreening intervals for the 2 diseases were 3 and 1 yr, respectively. On-site screening for periodontal probing depth has been included

in the KCIS since 2003. Per the suggestions of the World Health Organization, attendees aged 35 to 44 yr were targeted for a survey of periodontal probing depth based on a CPI. In the current study, we included those subjects fulfilling screening criteria for periodontal probing depth (aged 35–44 yr from 2003 to 2008) and colorectal cancer (aged 40–69 yr from 2000 to 2008). Finally, a total of 6,214 subjects aged 40 to 44 yr who participated in the KCIS between 2003 and 2008 formed our study population. All participants provided their written informed consent before attended the screening program.

Measurement of Periodontal Probing Depth

The protocol for periodontal examination was developed in a randomized controlled trial for the evaluation of treatments for periodontal disease (Lai *et al.*, 2008), and it evolved until 2008 (Lai *et al.*, 2007; Wang *et al.*, 2009). The CPI was used to record periodontal probing depth, ranging from 0 to 4, representing healthy (CIP 0), bleeding on probing (CPI 1), calculus (CPI 2), a 4- to 5-mm pocket (CPI 3), and a 6-mm or deeper pocket (CPI 4). The full mouth was divided into 6 sextants, from which the CPI was read on the basis of 1 or 2 index teeth (World Health Organization, 1997). According to CPI criteria, if no index tooth (or teeth) was present, then all the teeth in the sextant were examined. In such cases, the distal surface of the third molar was excluded to avoid pseudopockets. All subjects were examined by dentists with sufficient light sources for outreaching or reach-in activities. For each subject, the most severe score on a CPI reading among the 6 sextants was recorded as the final CPI score. All the dentists involved in the KCIS program were trained by a senior periodontist before their field practice. Calibration was measured with estimated Kappa statistics—0.55 to 0.61 for intraexaminer variability and 0.42 to 0.44 for inter-examiner variation—and was performed in the early stages of the KCIS (Lai *et al.*, 2007), indicating moderate to good reliability and validity between dentists.

Measurement of FHbC

Details of the colorectal cancer screening in the KCIS have been described (Yang *et al.*, 2006; Chen *et al.*, 2011). Participants in the KCIS program aged 40 yr and older were provided fecal immunochemical test collecting kits (OC-Sensor μ , Eiken, Japan) upon their arrival at the on-site screening activity. At the same time, standard instructions on how to collect samples were provided by trained public health nurses or volunteer health workers. One sample from a bowel movement was collected from each participant. The attendees were asked to return the samples to the nearest health center within 3 to 5 d. The collected samples were then stored in a 4°C refrigerator and sent to the central laboratory for reading no more than 7 d after the screening activity. The reading of FHbC was reported via an interval scale. Those subjects having no reading of FHbC were recorded as undetected. Subjects having a level of FHbC ≥ 100 ng/mL were referred to undergo colonoscopy to confirm whether they had adenoma or invasive carcinoma of the colon and rectum. Subjects having levels of FHbC less than the cutoff were invited to the next round of screening.

Demographic and Lifestyle Variables

In the setting of multiple integrated screenings in communities, the attendees were first registered in the screening informatics system with personal identification to ascertain that they resided in the city of Keelung. Biochemical examinations with serum samples collected after at least 8 hr of fasting and urine sample were obtained for chronic disease screening. Anthropometric measurements of body height, weight, waist circumference, and blood pressure were obtained by public health nurses, using a calibrated stadiometer and a digital scale. In addition, each participant was asked to complete a structured questionnaire or was interviewed by health volunteers, if illiterate, for information on their habits of smoking and alcohol intake (commencing age, quantity, and frequency of use), exercise habits, intake of meat and vegetables, personal disease histories, and family histories of cancer and chronic diseases.

Statistical Analysis

The distributions of demographic features, lifestyle data, and FHBc measurements by CPI score were tested with the chi-square test. We also compared the quantitative values of FHBc across CPI scores with the Kruskal-Wallis test because the FHBc was positively skewed. Because the CPI score is an ordinal variable, we were interested in assessing the different levels of FHBc by CPI values. Proportional odds logistic regression models were used to estimate the odds ratios of different FHBc levels for an increased CPI score, with adjustment for age, sex, education, smoking, alcohol intake, exercise, body mass index, and dietary intake of meat and vegetables. Owing to the skewness of FHBc, we did not directly use the original quantitative value of FHBc but instead categorized it into different levels.

We further aimed to assess whether FHBc varied with different CPI scores. Because approximately half the participants had undetected FHBc, we conducted further analysis focusing on those with detected FHBc. The differences in FHBc across CPI scores were tested with an analysis of variance after the logarithm transform of FHBc because the distribution of FHBc among those with positive values was still positively skewed. Duncan's test was used for *post hoc* pairwise difference.

All statistical tests were 2-sided with an alpha level of 0.05. The statistical analyses were performed with SAS software, version 9.2.

RESULTS

Table 1 shows the frequencies of demographic features, smoking, alcohol intake, exercise habits, body mass index, and intake of meat and vegetables, with the FHBc level classified according to different CPI scores. Only 7% of the subjects had healthy periodontal conditions (CPI = 0). The likelihood of having CPI 1, 2, and 3/4 was 14%, 48%, and 31%, respectively. Male sex, lower education level, smoking and alcohol intake, elevated body mass index, and a higher level of FHBc resulted in a greater likelihood of deep pockets ($p < .01$).

Table 2 shows the estimated results of the proportional odds logistic regression model for the incremental severity score of CPI. In univariate analysis, men had a 57% higher risk than

women (odds ratio [OR] = 1.57, 95% confidence interval [CI]: 1.42-1.73). One year of increasing age resulted in an 8% elevated risk (95% CI: 5%-12%). Compared with those subjects educated through college or beyond, senior high school-educated subjects and subjects with lower education levels were at a greater risk of 31% (OR = 1.31, 95% CI: 1.17-1.46) and 52% (OR = 1.52, 95% CI: 1.33-1.73), respectively. Smoking of 1-10, 11-20, and >20 cigarettes per day resulted in an increased risk of a greater severity score for the CPI, with estimated ORs of 1.43 (95% CI: 1.24-1.64), 2.04 (95% CI: 1.76-2.37), and 2.35 (95% CI: 1.77-3.13), respectively. The corresponding figures for use of alcohol were as follows: occasionally, 1.44 (95% CI: 1.27-1.65); 2 or 3 times per week, 1.42 (95% CI: 1.18-1.71); and 4 or more times per week, 1.90 (95% CI: 1.45-2.49). Exercising ≤ 60 min/wk (OR = 0.93, 95% CI: 0.83-1.04) or >60 min/wk (OR = 0.84, 95% CI: 0.74-0.94), compared with having no exercise habit, resulted in a lower risk of an increased CPI score. Elevated body mass index contributed to 35% greater risk for an increased CPI score (OR = 1.35, 95% CI: 1.22-1.49). The risk for an incremental increase in CPI score with FHBc ≥ 500 ng/mL, compared with undetected FHBc, was 1.54 times greater (95% CI: 1.00-2.38). Dichotomous FHBc with a cutoff of 100 ng/mL (positive fecal immunochemical test) led to a 32% elevated risk for a higher CPI score (OR = 1.32, 95% CI: 1.03-1.70), compared with a negative fecal immunochemical test. In the multivariable regression analysis, a positive fecal immunochemical test remained statistically significant (adjusted OR = 1.33, 95% CI: 1.03-1.73) after adjusting for confounders, among which sex, age, education, smoking, and elevated body mass index remained statistically significant but not alcohol intake, exercise, or frequent intake of meat and vegetables.

The mean values for FHBc increased with more severe scores for CPI—at 21.3 ± 156.3 , 26.0 ± 167.7 , 27.2 ± 151.1 , and 39.5 ± 255.7 ng/mL for CPI 0, CPI 1, CPI 2, and CPI 3/4, respectively (Table 1). The Figure shows the distribution of FHBc by different CPI scores. Among those subjects with positive readings, the mean values for FHBc were 46.3 ± 228.4 , 47.2 ± 223.8 , 58.4 ± 217.4 , and 80.8 ± 361.3 ng/mL for CPI 0, CPI 1, CPI 2, and CPI 3/4, respectively. The mean value of FHBc underwent a remarkable increase from CPI 1 to CPI 3/4 (Appendix Figure). The log-FHBc was significantly different across CPI scores ($p = .0078$). The *post hoc* comparison with Duncan's test indicated significant differences between the 2 groups for CPI 0 vs. CPI 1, CPI 0 vs. CPI 2, and CPI 0 vs. CPI 3/4.

The prevalence rate of colorectal neoplasms was higher in the category of CPI 2 than CPI 0 or 1, although there was a lower rate in CPI 3/4 (rare cases) compared with CPI 2 (Table 3). After adjusting for age and sex, the ORs for CPI 1, 2, and 3/4 were 1.48 (95% CI: 0.30-7.37), 1.72 (95% CI: 0.40-7.27), and 1.27 (95% CI: 0.29-5.68), respectively. The association was not statistically significant ($p = .7732$). An increased risk of a colorectal neoplasm was noted with an increasing level of FHBc ($p < .0001$).

DISCUSSION

In this study, we demonstrated a positive association between the severity of periodontal probing depth and FHBc in adults

Table 1. Distribution of FHbC by CPI Score for Participants 40 to 44 Yr Old Undergoing Periodontal Examination in KCIS

Variable	CPI 0		CPI 1		CPI 2		CPI 3/4		<i>p</i> ^a
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	
Subjects	431	6.9	870	14.0	2,993	48.2	1,920	30.9	
Sex									<.0001
Male	123	5.6	251	11.3	1,005	45.4	833	37.7	
Female	308	7.7	619	15.5	1,988	49.7	1,087	27.2	
Education									<.0001
College or beyond	154	8.6	297	16.5	865	48.2	479	26.7	
Senior high school	211	7.1	387	13.0	1,437	48.1	950	31.8	
Junior high school or less	66	4.7	177	12.6	676	48.1	485	34.5	
Smoking, cigarettes/d									<.0001
None	328	7.5	701	16.1	2,121	48.8	1,198	27.6	
1-10	62	7.3	84	9.9	404	47.7	297	35.1	
11-20	29	3.9	61	8.3	331	44.8	318	43.0	
20+	8	4.4	11	6.1	77	42.8	84	46.7	
Alcohol intake									<.0001
No	337	7.5	689	15.3	2,172	48.3	1,296	28.8	
Occasionally	53	5.6	99	10.4	457	47.9	345	36.2	
2-3 times/wk	29	6.7	40	9.3	207	48.0	155	36.0	
4+ times/wk	7	3.6	24	12.2	78	39.6	88	44.7	
Exercise habit, min/wk									.1872
None	159	6.7	308	13.0	1,128	47.8	767	32.5	
≤60	148	6.9	306	14.2	1,032	48.0	666	30.9	
>60	119	7.7	236	15.2	748	48.3	446	28.8	
Body mass index, kg/m ²									<.0001
<25	299	7.3	620	15.2	1,984	48.7	1,168	28.7	
≥25	129	6.1	249	11.8	991	46.8	750	35.4	
Meat intake									.7422
Infrequent	354	6.9	711	13.9	2,457	48.2	1,576	30.9	
Frequent	66	7.0	130	13.8	439	46.6	308	32.7	
Vegetable intake									.4464
Infrequent	318	7.0	617	13.5	2,197	48.2	1,424	31.3	
Frequent	102	6.8	228	15.2	705	47.0	464	31.0	
FHbC groups, ng/mL									<.0001
Undetected	233	7.3	391	12.2	1,601	49.9	982	30.6	
1-49	182	7.1	424	16.5	1,169	45.4	802	31.1	
50-99	7	3.3	28	13.3	119	56.7	56	26.7	
100-499	5	3.4	22	15.2	68	46.9	50	34.5	
≥500	4	5.3	5	6.7	36	48.0	30	40.0	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
FHbC, ng/mL	21.3	156.3	26.0	167.7	27.2	151.1	39.5	255.7	.0009
FHbC among FHbC levels detected, ng/mL	46.3	228.4	47.2	223.8	58.4	217.4	80.8	361.3	.0058

CPI, community periodontal index; FHbC, fecal hemoglobin concentration; KCIS, Keelung Community-based Integrated Screening.

^aCalculated with the chi-square test for all categorical variables and with the Kruskal-Wallis test for continuous values of FHbC across different CPI scores.

aged 40 to 44 yr. This positive association was further supported by the higher rate of colorectal adenoma observed in subjects with greater severity of periodontal probing depth. The link between periodontal probing depth and FHbC might be attributable to the common underlying mechanism being an inflammatory process for both outcomes. Periodontal disease has been postulated to be associated with a constellation of proinflammatory cytokines, such as C-reactive protein, TNF- α , and IL-6,

which have been suspected to be related to colorectal neoplasms, as demonstrated in previous studies (Grobewska *et al.*, 2008; Hopkins *et al.*, 2012; Huber *et al.*, 2012; Kang *et al.*, 2013).

The current finding on the link between periodontal probing depth and FHbC has been upheld by several empirical studies that have provided clues about both diseases in association with metabolic syndrome, one of the medical conditions affecting the

Table 2. Estimated Odds Ratios of Demographic Variables and FHbC Levels for Increasing CPI Score: Proportional Odds Logistic Regression Models

Variables	Univariate			Multivariable		
	OR	95% CI	<i>p</i>	aOR ^a	95% CI	<i>p</i>
Sex (male vs. female)	1.57	1.42-1.73	<.0001	1.27	1.12-1.45	.0003
Age	1.08	1.05-1.12	<.0001	1.08	1.04-1.12	<.0001
Education			<.0001			<.0001
College or beyond	1.00	(Reference)		1.00	(Reference)	
Senior high school	1.31	1.17-1.46		1.32	1.17-1.47	
Junior high school or less	1.52	1.33-1.73		1.50	1.30-1.73	
Smoking, cigarettes/day			<.0001			<.0001
None	1.00	(Reference)		1.00	(Reference)	
1-10	1.43	1.24-1.64		1.21	1.03-1.42	
11-20	2.04	1.76-2.37		1.57	1.31-1.87	
20+	2.35	1.77-3.13		1.71	1.25-2.32	
Alcohol intake			<.0001			.2556
No	1.00	(Reference)		1.00	(Reference)	
Occasionally	1.44	1.27-1.65		1.12	0.96-1.29	
2-3 times/wk	1.42	1.18-1.71		0.99	0.81-1.21	
4+ times/wk	1.90	1.45-2.49		1.24	0.93-1.65	
Exercise habit			.0152			.1822
No	1.00	(Reference)		1.00	(Reference)	
≤60 min/wk	0.93	0.83-1.04		0.95	0.85-1.07	
>60 min/wk	0.84	0.74-0.94		0.89	0.79-1.01	
Body mass index (≥25 vs. <25 kg/m ²)	1.35	1.22-1.49	<.0001	1.19	1.07-1.32	.0011
Meat intake (frequent vs. infrequent)	1.05	0.92-1.20	.4483	0.97	0.84-1.10	.6076
Vegetable intake (frequent vs. infrequent)	0.96	0.86-1.07	.4793	1.06	0.95-1.19	.2844
FHbC groups, ng/mL			.0907			.0473
Undetected	1.00	(Reference)		1.00	(Reference)	
1-49	0.93	0.84-1.02		0.92	0.84-1.02	
50-99	0.98	0.76-1.27		0.88	0.67-1.16	
100-499	1.16	0.85-1.59		1.13	0.82-1.55	
≥500	1.54	1.00-2.38		1.65	1.06-2.58	
FHbC groups, ng/mL			.0300			.0297
<100	1.00	(Reference)		1.00	(Reference)	
≥100	1.32	1.03-1.70		1.33 ^a	1.03-1.73	

Proportional odds logistic regression has the following model form:

$$\text{Log}\left(\frac{\pi_1 + \pi_2 + \pi_3}{\pi_0}\right) = \alpha_1 + X\beta + \varepsilon_1$$

$$\text{Log}\left(\frac{\pi_2 + \pi_3}{\pi_0 + \pi_1}\right) = \alpha_2 + X\beta + \varepsilon_2$$

$$\text{Log}\left(\frac{\pi_3}{\pi_0 + \pi_1 + \pi_2}\right) = \alpha_3 + X\beta + \varepsilon_3$$

where π_0 , π_1 , π_2 , and π_3 represent the probability of being CPI 0, 1, 2, and 3/4, respectively; α_i ($i = 1, 2, 3$) is the intercept term for comparison among adjacent categories that bear ordinal property; β is the regression coefficients for the corresponding covariate vector; and ε_i is the error term.

aOR, adjusted odds ratio; CI, confidence interval; CPI, community periodontal index; FHbC, fecal hemoglobin concentration; OR, odds ratio.

^aAdjusted odds ratios for FHbC groups in 5 categories and 2 categories were estimated in 2 separate models. The aORs for confounding factors were derived from the model with 5 FHbC groups.

Table 3. Distribution of Endoscopic Findings by CPI and FHbC Levels

Variables	Free of Colorectal Neoplasm		Colorectal Neoplasm (per 1,000)		α OR ^a	95% CI	p
	n	%	n	%			
Attendants	6,168		46				
CPI							.7732
CPI 0	429	99.5	2	4.7	Reference		
CPI 1	864	99.3	6	6.9	1.48	0.30-7.37	
CPI 2	2,968	99.2	25	8.4	1.72	0.40-7.27	
CPI 3/4	1,907	99.3	13	6.8	1.27	0.29-5.68	
FHbC level, ng/mL							<.0001
Undetected	3,195	99.6	12	3.7	Reference		
1-50	2,566	99.6	11	4.3	1.13	0.50-2.58	
51-100	210	100	0	0	0.00	n/a	
101-500	131	90.3	14	96.6	28.02	12.64-62.10	
>500	66	88.0	9	120	40.92	16.47-101.67	

α OR, adjusted odds ratio; CI, confidence interval; CPI, community periodontal index; FHbC, fecal hemoglobin concentration; n/a, not available.

^aAdjusted for age and sex.

pathophysiological pathways related to inflammatory underpinning. Previous studies have already demonstrated the association between metabolic syndrome and periodontal disease (Wang *et al.*, 2009; Morita *et al.*, 2010; Furuta *et al.*, 2013). The association between metabolic syndrome and colorectal neoplasms has also been well documented in several studies (Chen *et al.*, 2004; Chiu *et al.*, 2007). Both these aspects support our results regarding the relationship between FHbC and periodontal probing depth and between colorectal neoplasms and periodontal probing depth.

FHbC has been demonstrated to be a good predictor of the subsequent incidence of and mortality from colorectal cancer and adenoma, with a dose-response effect (Chen *et al.*, 2011, 2013; Yen *et al.*, 2014). Based on the greater predictive validity of FHbC for the risk of colorectal neoplasms, the association between FHbC and periodontal probing depth in young adults provides an insight into the identification of subjects at high risk for colorectal neoplasms, by examining periodontal probing depth at earlier ages. In light of our results, people with higher CPI scores potentially have a higher risk for developing colorectal neoplasms later in life. These subjects should undergo a full periodontal examination, and, if found to indeed have moderate or severe periodontitis, they might be counseled to begin fecal immunochemical test screening at a younger age than those who were allocated lower CPI scores at the screening.

There were 3 limitations of this study. First, CPI has limitations in reflecting inflammatory burden. CPI score uses index teeth (tooth) in each sextant; thus, it does not reflect the extent of disease in all the dentition. The recording of CPI score is based on a hierarchical method such that only the worst category of the findings is recorded, rather than all signs together. Some information is therefore lost. A pocket might not necessarily accompany more inflammation than calculus or gingival bleeding and vice versa. Thus, the extent of inflammation might not

Figure. Fecal hemoglobin (FHbC) level by community periodontal index (CPI) score among 40- to 44-year-old Taiwanese participating in the KCIS program, 2003-2008 ($N = 6,214$).

have been exactly reflected. In contrast, probing depth is 1 of 2 components of clinical attachment loss and is more closely related to infection and/or inflammation than the other component: gingival recession. However, some situations can complicate the indication of periodontitis. It is possible that deep pockets could be caused by situations other than periodontitis, such as swelling due to hormonal changes during pregnancy, local irritants (*e.g.*, removable partial dentures; however, given the young age of the individuals examined, the chance of this factor is small), food impaction, inflammatory diseases, and medications causing gingival overgrowth. Nevertheless, this study shed light on an association between FHbC and periodontal probing depth, in the context of CPI score.

Second, our study design was cross sectional and thereby precluded longitudinal follow-up to observe any incident cases of colorectal neoplasms over time and to determine the temporal sequence of severe periodontal disease (suspected putative agent) and new cases of colorectal neoplasms (outcome). However, because the mean age of occurrence of periodontal disease was generally younger than that of the occurrence of colorectal neoplasms, we believe that deep pockets might occur before colorectal neoplasms. Finally, our study was limited to ages 40 to 44 yr, so the results cannot be generalized to older age groups. The elucidation of the relationship between FHbC and periodontal probing depth should be further validated by extending the target population to elderly people in a longitudinal follow-up study.

In conclusion, a positive association between FHbC and periodontal probing depth in 40- to 44-yr-old adults was demonstrated by using a population-based study derived from a multiple-screening program. Given the strong association between FHbC and colorectal neoplasms, these results could have significant implications for the identification of high-risk subjects who are susceptible to deep pockets to undergo colorectal cancer screening at earlier ages.

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