RESEARCH ARTICLE

Overweight Relation to Liver Fluke Infection among Rural Participants from 4 Districts of Nakhon Ratchasima Province, Thailand

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Abstract

A cross-sectional survey was conducted among 730 participants from 4 rural districts of Nakhon Ratchasima province, Thailand, with a reported high incidence of liver fluke infection. This study was aimed to examine and evaluate the nutritional status in relation to *Opisthorchis viverrini* infection. Participants were purposive selected from Chum Phuang, Mueang Yang, Bua Yai, and Kaeng Sanam Nang districts. Stool samples were prepared by Kato Katz technique and then assessed by microscopy. Anthropometry was evaluated according to the body mass index from weight and height. Descriptive statistics and Spearman rank correlation coefficients were used to evaluate the association between the nutritional status and *O. viverrini* infection. Of 1.64% infected with *O. viverrini* the highest proportions were found in age groups ≥61 and 41-50 years old, Mueang Yang district. The majorities of participants had normal weight (32.2%), followed by class II obesity (28.1%), class I obesity (21.8%), underweight (10.3%), and class III obesity (8.63%). Nutritional status with class II obesity (rS=0.639, p<0.01) and class I obesity (rS=0.582, p<0.05), had moderately statistical significant correlations with *O. viverrini* infection. Meanwhile, normal weight (rS=0.437, p<0.05) and class III obesity (rS=0.384, p<0.05) demonstrated lower statistical significance. These findings raise the possibility that infection with *O. viverrini* may contribute to fat deposition and thereby have long-term consequences on human health. Further studies are needed to better understand whether *O. viverrini* contributes directly to fat deposition and possible mechanisms.

Keywords: Nutritional status - overweight - obesity - liver fluke infection - Thailand

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Introduction

Opisthorchis viverrini is a serious health problem in Thailand, particularly in the northeast and north region (Sripa et al., 2010; Sithithaworn et al., 2012; Kaewpitoon et al., 2015b). The distribution *O. viverrini* infection in Nakahon Ratchasima province has been reported in human and intermediate host suggested that rural districts are still a problem with this *O. viverrini* (Kaewpitoon et al., 2012a, c; Kaewpitoon et al., 2016a, c, d). In addition, mortality rate of liver cancer and cholangiocarcinoma (CCA) have been reported and found that Nakhon Ratchasima province has 13.67-16.2 per 100,000 populations. Eradication of the fluke and identification of high-risk populations are urgently needed (Sripa and pairojkul, 2008). A multi-factorial risks are associated to CCA mainly *O. viverrini* (Bhamarapravati and Viranuvatti, 1966; Harinasuta and Vajrasthira, 1960; Sonakul et al., 1978; Thamavit et al., 1978; Mairiang et al., 1992, 1993; IARC, 1994), hepatitis C virus infection, chronic nonalcoholic liver disease, cirrhosis, diabetes, obesity, and smoking (Tyson and El-Serag, 2011; Ettel et al., 2015).

Recently, intestinal parasites, virus and bacterial infections are positively associated with obesity and

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adiposity in vitro and in animal models. A moderate or heavy infection with *E. coli* may contribute to fat deposition and thereby have long-term consequences on human health (Zavala et al., (2015). Furthermore, congenital toxoplasmosis was found in a mother with type 2 diabetes mellitus (Sato et al., 2014). The 10-year follow-up of the Bambuí (Brazil) Cohort study of aging indicates that the obesity paradox found in an elderly population with a high prevalence of Chagas disease (Beleigoli et al., 2013). Meanwhile, liver fluke infection particular *O. viverrini* on nutritional status particularly overweight, obesity, and underweight are lack of data. Recently, *O. viverrini* infection is well known to cause inflammation-mediated oxidative/nitrative stress resulting in chronic periductal fibrosis, which is a risk factor of CCA (Pinlaor et al., 2004, Prakobwong et al., 2009, Sripa et al., 2012). Furthermore, chronic inflammation leads to fibrosis involving the hepatic parenchyma resulting in biliary tree changes, which can contribute to cirrhosis and malignancy (Tyson and El-Serag 2011, Eaton et al., 2013). Oxidative stress in the liver and bile duct is sometimes accompanied by primary sclerosing cholangitis and cholestasis (Sekine et al., 2006). The morphological and functional changes of bile canaliculi are well demonstrated in bile duct ligation-induced cholestasis in rats (Takakuwa et al., 2002) including *O. viverrini* (Charoensuk et al., 2014), suggested that *O. viverrini* infection induces morphological and functional changes of bile canaliculi in association with the decrease of bile volume in *O. viverrini*-infected hamsters (Charoensuk et al., 2014). These results raise the possibility that a infection with *O. viverrini* may contribute to fat deposition and thereby have long-term consequences on human health. Therefore, this aimed to examine and evaluate the nutritional status and *O. viverrini* infection in the participant from Chum Phuang, Mueang Yang, Bua Yai, and Kaeng Sanam Nang districts. The results may useful supports the further studies regarding *O. viverrini* contributes directly to fat deposition and possible mechanisms.

Materials and Methods

A cross-sectional survey study was conducted among 4 districts of Nakhon Ratchasima province, northeast Thailand, between June 2015 and March 2016. Nakhon Ratchasima is one of the northeast provinces of Thailand. Neighbouring provinces are (clockwise, from north) Chaiyaphum, Khon Kaen, Buriram, Sa Kaeo, Prachinburi, Nakhon Nayok, Saraburi, and Lopburi. The province is subdivided into 32 districts. The districts are further subdivided into 263 subdistricts and 3,743 villages. The province is coverage areas 20,494 km2 (7,913 sq mi), and 2,628,818 populations. Study areas included Chum Phuang (Chum Phuang, Prasuk, Tha Lat, Sarai, Talat Sai, Non Rang, Nong Lak, Non Tum, Non Yo sub-districts), Kaeng Sanam Nang (Kaeng Sanam Nang, Non Samran, Bueng Phalai, Si Suk, Bueng Samrong sub-district), Mueang Yang (Mueang Yang, Krabueang Nok, Lahan Pla Khao, Non Udom sub-district), and Bua Yai district (Bua Yai, Huai Yang, Sema Yai, Nong Bua Sa-at, Non Thong Lang, Kut Chok, Dan Chang, Khun Thong, Nong Chaeng Yai sub-district). Participants were purposive selected from 2 parts including (1) 355 participants based on database that has been reported in Asian Pacific Journal of Cancer Prevention (*O. viverrini* infections in Mueang Yang, Bua Yai, and Chum Phuang district was 2.82%, 2.48%, and 1.84%, respectively) (Kaewpitoon et al., 2016a), and (2) 375 participants from Kaeng Sanam Nang district were included. Participants were completed Korat CCA verbal screening test (KCVST) which contained the history with (1) opisthorchiasis (2) under-cooked fish consumption, (3) praziquantel used (4) cholangitis or cholecystitis, (5) relative family with CCA (6) naïve northeastern people, (7) agriculture, and (8) alcohol consumption. Population at risk was identified following 1+2+3+4+5+6+7+8, who had a score with more than 5 points was selected.

Data was included gender, age, weight, height, and stool samples. *O. viverrini* infections were examined by using Kato-Katz techniques (Peters et al., 1980; Tarafder et al., 2010). Briefly, approximately 1 gram of stool was placed on scrap paper and a piece of nylon screen was pressed on top so that some of the stool sieved through the screen and accumulated on top. A flat-sided spatula was scraped across the upper surface of the screen to collect the sieved stool. A template was placed on the slide and the sieved stool was added with the spatula so that the hole in the template was completely filled. The spatula was passed over the filled template to remove excess stool from the edge of the hole. The template was removed carefully so that a cylinder of stool was left on the slide. The stool material was covered with a pre-soaked cellophane strip. The slide was inverted and the stool sample was pressed firmly against the hydrophilic cellophane strip to spread evenly. The slide was placed on the bench with

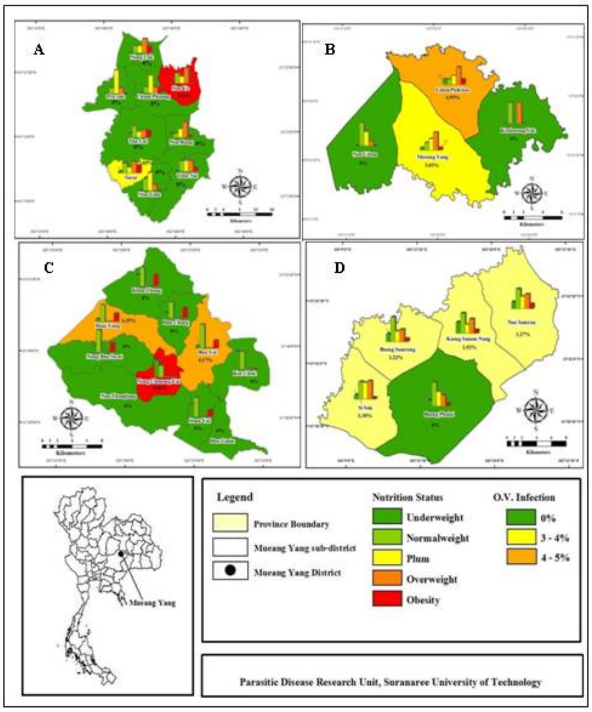

Figure 1. Nutritional Status and *O. viverrini* Infection in 4 Districts of Nakhon Ratchasima proince, Thailand; A: Chum Phuang, B: Mueang Yang, C: Bua Yai, and D: Kang Sanam Nang district

cellophane upwards to enable the evaporation of water while glycerol cleared the stool. The slide was kept for 30 minutes at room temperature to clear the stool material, prior to microscopic examination. Anthropometry was evaluated following the appropriate body-mass index for Asian populations and its implications for policy and intervention strategies (WHO, 2004). Briefly; underweight (BMI < 18.50 Kg/M2), normal range (BMI = 18.50-24.99 Kg/M2), Overweight: class I obese (BMI = 23.00-24.99 Kg/M2), class II obese (BMI = 25.00-29.99 Kg/M^2), and class III obese (BMI ≥ 30 Kg/$M^{2)}$.

Software; ArcGIS; was used for created the database of geographic information system, analysis the spatial and descriptive data. Spatial and Attribute databases were used for GIS Database. The secondary data included the point of sub- district boundaries and district boundaries, used for created the spatial database. Nutritional status and *O. viverrini* infection were used for created the arttribute database. Data management were collected the spatial database (Figure 1). Descriptive and analytical statistical data were analyzed with SPSS software. Spearman rank correlation coefficient was used for evaluate the association between the nutritional status and *O. viverrini* infection.

Results

Of 730 participants were included in this cross-sectional survey study. The majorities of participants were male (54.25%), age group between 51-60 years old (36.85%), and habituated in Kang Sanam Nang district (51.37%), respectively. *O. viverrini* infection was examined with Kato Katz smear preparation and microscopy, found that 0.68% and 0.96% of infection

Table 1. *O. viverrini* Infection among Participants from 4 Districts of Nakhon Ratchasima Province, Thailand

Demographic data	participants		*O. viverrini infection*			
	n	%	Positive	%	Negative	%
Gender						
Male	401	54.93	5	0.68	396	54.25
Female	329	45.07	7	0.96	322	44.11
Total	730	100.00	12	1.64	718	98.36
Age group						
≤40	79	10.82	1	0.14	78	10.68
41-50	218	29.86	4	0.55	214	29.32
51-60	271	37.12	2	0.27	269	36.85
≥61	162	22.19	5	0.68	157	21.51
Total	730	100.00	12	1.64	718	98.36
District/sub-district						
Chum Phuang	163	22.33	3	1.84	160	98.16
Chum Phuang	11	1.51	0	0.00	11	6.75
Prasuk	11	1.51	0	0.00	11	6.75
Tha Lat	29	3.97	0	0.00	29	17.79
Sarai	29	3.97	1	0.61	28	17.18
Talat Sai	15	2.05	0	0.00	15	9.20
Non Rang	21	2.88	0	0.00	21	12.88
Nong Lak	10	1.37	0	0.00	10	6.13
Non Tum	11	1.51	0	0.00	11	6.75
Non Yo	26	3.56	2	1.23	24	14.72
Bua Yai	121	16.58	3	2.48	118	97.52
Bua Yai	20	2.74	1	0.83	19	15.70
Huai Yang	18	2.47	1	0.83	17	14.05
Sema Yai	6	0.82	0	0.00	6	4.96
Nong Bua Sa-at	15	2.05	0	0.00	15	12.40
Non Thong Lang	15	2.05	0	0.00	15	12.40
Kut Chok	7	0.96	0	0.00	7	5.79
Dan Chang	20	2.74	0	0.00	20	16.53
Khun Thong	13	1.78	0	0.00	13	10.74
Nong Chaeng Yai	7	0.96	1	0.83	6	4.96
Kaeng Sanam Nang	375	51.37	4	1.07	371	98.93
Kaeng Sanam Nang	52	7.12	1	0.27	51	13.60
Non Samran	83	11.37	1	0.27	82	21.87
Bueng Phalai	79	10.82	0	0.00	79	21.07
Si Suk	80	10.96	1	0.27	79	21.07
Bueng Samrong	81	11.10	1	0.27	80	21.33
Mueang Yang	71	9.73	2	2.82	69	97.18
Mueang Yang	33	4.52	1	1.41	32	45.07
Krabueang Nok	5	0.68	0	0.00	5	7.04
Lahan Pla Khao	24	3.29	1	1.41	23	32.39
Non Udom	9	1.23	0	0.00	9	12.68
Total	730	100.00	12	1.64	718	98.36

Table 2. Nutritional Status among Participants from 4 Districts of Nakhon Ratchasima Province, Thailand

Demographic data	Nutritional status (BMI; Kg/M^2)											
	Underweight		Normal		Class I Obese		Class II Obese		Class III Obese		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Gender												
Male	37	9.25	134	33.50	88	22.00	119	29.75	22	5.50	400	54.79
Female	31	9.39	101	30.61	71	21.52	86	26.06	41	12.42	330	45.21
Total	68	9.32	235	32.19	159	21.78	205	28.08	63	8.63	730	100.00
Age group												
≤40	9	11.54	27	34.62	14	17.95	16	20.51	12	15.38	78	10.68
41-50	13	5.96	74	33.94	50	22.94	51	23.39	30	13.76	218	29.86
51-60	29	10.70	83	30.63	61	22.51	86	31.73	12	4.43	271	37.12
≥61	17	10.43	51	31.29	34	20.86	52	31.90	9	5.52	163	22.33
Total	68	9.32	235	32.19	159	21.78	205	28.08	63	8.63	730	100.00
Sub-district												
Chum Phuang	1	9.09	2	18.18	4	36.36	2	18.18	2	18.18	11	1.51
Prasuk	1	9.09	2	18.18	5	45.45	2	18.18	1	9.09	11	1.51
Tha Lat	3	10.34	9	31.03	5	17.24	6	20.69	6	20.69	29	3.97
Sarai	1	3.45	8	27.59	5	17.24	9	31.03	6	20.69	29	3.97
Talat Sai	1	6.67	4	26.67	4	26.67	4	26.67	2	13.33	15	2.05
Non Rang	3	14.29	3	14.29	5	23.81	8	38.10	2	9.52	21	2.88
Nong Lak	1	10.00	2	20.00	2	20.00	3	30.00	2	20.00	10	1.37
Non Tum	1	9.09	3	27.27	4	36.36	2	18.18	1	9.09	11	1.51
Non Yo	1	3.85	7	26.92	5	19.23	10	38.46	3	11.54	26	3.56
Bua Yai	1	5.00	8	40.00	6	30.00	3	15.00	2	10.00	20	2.74
Huai Yang	0	0.00	5	27.78	4	22.22	7	38.89	2	11.11	18	2.47
Sema Yai	1	16.67	2	33.33	1	16.67	1	16.67	1	16.67	6	0.82
Nong Bua Sa-at	1	6.67	6	40.00	1	6.67	5	33.33	2	13.33	15	2.05
Non Thong Lang	1	6.67	7	46.67	1	6.67	6	40.00	0	0.00	15	2.05
Kut Chok	1	14.29	2	28.57	0	0.00	4	57.14	0	0.00	7	0.96
Dan Chang	1	5.00	5	25.00	3	15.00	7	35.00	4	20.00	20	2.74
Khun Thong	2	15.38	4	30.77	1	7.69	4	30.77	2	15.38	13	1.78
Nong Chaeng Yai	1	14.29	1	14.29	1	14.28	4	57.14	0	0.00	7	0.96
Kaeng Sanam Nang	10	19.23	18	34.62	8	15.38	13	25.00	3	5.77	52	7.12
Non Samran	8	9.64	29	34.94	18	21.69	21	25.31	7	8.44	83	11.37
Bueng Phalai	7	8.86	33	41.77	20	25.32	15	18.99	4	5.06	79	10.82
Si Suk	6	7.50	24	30.00	23	28.75	25	31.25	2	2.50	80	10.96
Bueng Samrong	10	12.35	35	43.21	15	18.52	17	20.99	4	4.94	81	11.10
Mueang Yang	2	6.06	6	18.18	9	27.27	14	42.42	2	6.06	33	4.52
Krabueang Nok	0	0.00	2	40.00	1	20.00	2	40.00	0	0.00	5	0.68
Lahan Pla Khao	3	12.50	3	12.50	5	20.83	10	41.67	3	12.50	24	3.29
Non Udom	0	0.00	5	55.56	3	33.33	1	11.11	0	0.00	9	1.23
Total	68	9.32	235	32.19	159	21.78	205	28.08	63	8.63	730	100.00

Table 3. Association Between Nutritional Status and *O. viverrini* Infection in 4 Districts of Nakhon Ratchasima Province, Thailand

Nutritional status	O. viverrini infection
Underweight	0.301
Normal weight	0.437*
Overweight	
Class I Obese	0.582**
Class II Obese	0.639**
Class III Obese	0.384*

* Correlation is significant at the 0.05 level; ** Correlation is significant at the 0.01 level

was male and female. The highest of infection was found in age group ≥61 and 41-50 years old with 0.68% and 0.55%, respectively. Meanwhile, the highest of infection was found in Mueang Yang districts (2.82%), and followed by Bua Yai (2.48%), Chum Phuang (1.84%), and Kaeng Sanam Nang (1.07%), respectively (Table 1).

Nutritional status was examined and evaluated following Asian guideline standard with body mass index. The majorities of participants were normal nutritional status (32.19%), and followed by class II obese (28.08%), class I Obese (21.78%), underweight (10.27%), and class III Obese (8.63%), respectively. Gender, Age group, and districts were not statistical significant different in each nutritional status (Table 2, Figure 1).

Nutritional status had a statistical significant correlated to *O. viverrini* infection in 4 districts of Nakhon Ratchasima province. Nutritional status with class II Obese (rS=0.639, $p<0.01$) and class I Obese (rS=0.582, $p<0.05$), had moderately statistical significant correlated to *O. viverrini* infection. Meanwhile, normal weight (rS=0.437, $p<0.05$) and class III Obese (rS=0.384, $p<0.05$) had lowly statistical significant correlated to *O. viverrini* infection, respectively. Surprisingly, underweight had no statistical significant correlated to *O. viverrini* infection (rS=0.301, $p>0.05$) (Table 3).

Discussion

O. viverrini infection and CCA are a serious health problem in Thailand, particularly in the northeast and north region (Kaewpitoon et al., 2008; Sripa et al., 2010; Sithithaworn et al., 2012; Kaewpitoon et al., 2015b). The *O. viverrini* infection and CCA rate have been reported in Nakhon Ratchasima province by many investigators (Sripa and pairojkul, 2008; Kaewpitoon et al., 2012a, c; Kaewpitoon et al., 2016a, c, d). Previously, we reported that *O. viverrini* infections in Mueang Yang, Bua Yai, and Chum Phuang district was 2.82%, 2.48%, and 1.84%, respectively) (Kaewpitoon et al., 2016a). Meanwhile, in this study we found that 1.07% of *O. viverrini* infections in Kaeng Sanam Nang district, and found frequently in the elderly age group. This result is similar to previous reports in Surin province, Thailand (Kaewpitoon et al., 2012b; 2015c,f). In addition, rural elderly indicated that they have an under- or over-nutritional status. Some elderly show behavior regarding food consumption that is related to liver fluke infection that needs to be improved, so that health education pertaining good nutrition is required (Kaewpitoon et al., 2015g). *O. viverrini* is associated to CCA that has been reported in both of human and animal model (Bhamarapravati and Viranuvatti, 1966; Harinasuta and Vajrasthira, 1960; Sonakul et al., 1978; Thamavit et al., 1978; Mairiang et al., 1992, 1993; IARC, 1994).

Overweight and obesity are considered a serious health problem in Thailand. A cross-sectional population survey of 16,596 Thais aged 3 years and over was conducted and found a high prevalence of overweight and obesity in nationally representative sample of the Thai population. Higher rates of overweight and obesity prevalence were computed using the WPRO standard when compared to the WHO standard (Jitnarin et al., 2011). In addition, Non-communicable diseases are estimated to account for 6% of all deaths with diabetes; the related obesity (WHO, 2010). Recently, nutritional status was examined in 4 districts of Nakhon Ratchasima province, Thailand, and found that the majorities of participants were normal nutritional status (32.19%), and followed by Obese class II (28. 08%), Obese class I (21.78%), underweight (10.27%), and class III Obese (8.63%), respectively. Furthermore, nutritional status with class II Obese ($rS=0.639$, $p<0.01$) and class I Obese ($rS=0.582$, $p<0.05$), had moderately statistical significant correlated to *O. viverrini* infection. Meanwhile, normal weight ($rS=0.437$, $p<0.05$) and class III Obese ($rS=0.384$, $p<0.05$) had lowly statistical significant correlated to *O. viverrini* infection, respectively. Surprisingly, underweight had no statistical significant correlated to *O. viverrini* infection ($rS=0.301$, $p>0.05$). The mechanism of obesity and liver fluke infection are unclear. However, liver fluke infection was found located in common bile ducts and lead to chronic periductal fibrosis (Pinlaor et al., 2004, Prakobwong et al., 2009, Sripa et al., 2012), morphological and functional changes of bile canaliculi (Charoensuk et al., 2014), and primary sclerosing cholangitis and cholestasis (Sekine et al., 2006).

Based on the protozoan infection has been reported, intestinal parasites is positively associated with obesity and adiposity in vitro and in animal models. A total of 296 school-aged children from a rural area in Querétaro, Mexico, participated and measured the anthropometry and body fat. A fresh stool sample was collected from each child and analyzed for parasites. The result suggested that children with moderate-high infection with Entamoeba coli have higher percentage of body and abdominal fat than non-infected children. These findings raise the possibility that a moderate or heavy infection with E. coli may contribute to fat deposition and thereby have long-term consequences on human health (Zavala et al (2015). Furthermore, congenital toxoplasmosis was found in a mother with type 2 diabetes mellitus (Sato et al., 2014). Reeves et al (2015) estimate the possible association between Toxoplasma gondii infection and obesity in a sample of 999 psychiatrically healthy adults. In this sample, individuals with positive T. gondii serology had twice the odds of being obese compared to seronegative individuals ($p=0.01$). Further, individuals who were obese had significant higher T. gondii IgG titers compared to individuals who were non-obese. The 10-year follow-up of the Bambuí (Brazil) Cohort study of aging indicates that the obesity paradox found in an elderly population with a high prevalence of Chagas disease (Beleigoli et al., 2013). Several microbes are linked to obesity in animals and humans. Linking the two phenomenon is the immunological property of adipocytes and their progenitors. For instance, proliferating pre-adipocytes share embryonic origin with immune cells and exhibit phagocytic activity. Taken together it appears that there is a close interrelationship between adipose tissue, inflammatory response, immune system and infections. Hence, it is conceivable that in response to certain infections, adipose tissue expands similar to the expansion of cells of the immune system. The impaired immune function of adipose tissue in obesity may exacerbate infections. Considering the global obesity epidemic, it is necessary to further investigate both phenomena (Hegde and Dhrandhar, 2013).

However, based on data of intestinal helminthic infection suggested that helminths improve insulin sensitivity and enhance M2 macrophage numbers in WAT of obese mice (Geach, 2015). In addition, chronic low-grade inflammation associated with obesity contributes to insulin resistance and type 2 diabetes. Helminth parasites are the strongest natural inducers of type 2 immune responses, and short-lived infection with rodent nematodes was reported to improve glucose tolerance in obese mice. The data suggesting that chronic helminth infection and helminth-derived molecules protect against metabolic disorders by promoting a T helper 2 (Th2) response, eosinophilia, and WAT M2 polarization (Hussaarts et al., 2015). Obesity is associated with a chronic low-grade inflammation characterized by increased levels of proinflammatory cytokines that are implicated in disrupted metabolic homeostasis. Parasitic nematode infection induces a polarized Th2 cytokine response and has been explored to treat autoimmune diseases. Parasitic nematode infection has preventive and therapeutic effects against the development of obesity and associated features of metabolic dysfunction in mice (Yang et al., 2013). Okada et al (2013) indicates that Trichinella infection increases the ratio of M2/M1 systemically, which results in an improvement in pro-inflammatory state in adipose tissue and amelioration of glucose tolerance in obese mice. Meanwhile, long-term effect of previous schistosome infection reduces the risk of metabolic syndrome among Chinese men (Shen et al., 2015).

Obesity is a global public health problem that is linked with morbidity, mortality, and functional limitations and has limited options for sustained interventions. Novel targets for prevention and intervention require further research into the pathogenesis of obesity. Consistently, elevated markers of inflammation have been reported in association with obesity, but their causes and consequences are not well understood. An emerging field of research has investigated the association of infections and environmental pathogens with obesity, potential causes of low grade inflammation that may mediate obesity risk (Reeves et al., 2015). Several microbes are linked to obesity in animals and humans. On the one hand, various microbes, including animal and human viruses, bacteria, parasites and scrapie agents, increase adiposity in several animal models. Some of these microbes show an association with human obesity, but conclusive evidence for a causative role of microbes in human obesity is lacking. On the other hand, obese individuals show an altered response to infections. Obesity is often associated with impaired immune function, which may lead to increased susceptibility to infection with a number of different pathogens. Hence, certain microbes appear to induce obesity, whereas, obesity itself may exacerbate certain other infections (Hegde and Dhrandhar, 2013). Recently, researchers discovered a prokaryotic, Type II fatty acid synthesis (FAS) pathway associated with the plastid-like organelle (apicoplast) of Plasmodium and Toxoplasma has provided a wealth of novel drug targets. This pathway is both essential and fundamentally different from the cytosolic Type I pathway of the human host, apicoplast FAS has tremendous potential for the development of parasite-specific inhibitors (Goodman and McFadden, 2007). From above data suggests that fat synthesis, overweight, and obesity are useful for parasitic infection particularly protozoan infection, on the other hand, strongly evident indicates that nematodes and blood fluke lead to nutrition. The association between nutritional status and parasitic infection may up to various species that lead to under/or over nutrition.

In conclusion, this recent result is the first reports about overweight included class I and II obese is associated to liver fluke infection. However, the mechanism is unclear, these findings raise the possibility that an infection with *O. viverrini* may contribute to fat deposition and thereby have long-term consequences on human health. Further studies are needed to better understand if *O. viverrini* contributes directly to fat deposition and possible mechanisms.

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