Industrial Health 2013, **51**, 193–201

Original Article

A Single-item Global Job Satisfaction Measure Is Associated with Quantitative Blood Immune Indices in White-collar Employees

Akinori NAKATA[1, 2]*, Masahiro IRIE[3] and Masaya TAKAHASHI[4]

[1] University of Occupational and Environmental Health, Japan
[2] Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, USA
[3] Institute of Health Science, Kyushu University, Japan
[4] National Institute of Occupational Safety and Health, Japan

Received May 25, 2012 and accepted October 18, 2012
Published online in J-STAGE November 28, 2012

Abstract: Although a single-item job satisfaction measure has been shown to be reliable and inclusive as multiple-item scales in relation to health, studies including immunological data are few. The purpose of this study was to evaluate the validity of single-item job and family life satisfaction based on its association with immune indices. A total of 189 white-collar employees (70% men) underwent a blood draw for the measurement of natural killer (NK), total T, and B cell counts as well as plasma immunoglobulin (Ig) G concentrations and completed single-item job and family life satisfaction measures, respectively. The response options for satisfaction measures were 'dissatisfied' (coded 1) to 'satisfied' (coded 4). Spearman's partial correlations controlling for cofactors revealed that increased job satisfaction was positively associated with NK cells (r_{sp}=0.201, *p=0.007*) and IgG (r_{sp}=0.178, *p=0.018*), while family life satisfaction was unrelated to immune indices. Those who reported a combination of low job/low family life satisfaction had significantly lower NK and higher B cell counts than those with a high job/high family life satisfaction. Our study suggests that the single-item summary measure of job satisfaction, but not family life satisfaction, may be a valid tool to evaluate immune status in healthy white-collar employees.

Key words: Job satisfaction, Family life satisfaction, Single-item, Immune system, Worker, Occupational health psychology, Psychoimmunology, Work condition

Introduction

Job satisfaction is a central concept in occupational health psychology because it is one of the most widely studied topics in the area and has frequently been used as a summary measure of workers' health and well-being[1, 2]. To date, a number of instruments (30+ measures) has been developed to measure both global and facet-specific job satisfaction; however, there are only a handful of instruments that hold a high level of reliability and construct validity[3]. In addition, such instruments typically contain multiple items, most frequently from 10 to 40, which are encouraged for the conduct of scholarly research but often considered infeasible or user-unfriendly for routine monitoring at the workplaces.

In contrast to multi-item job satisfaction scales, single-item measures have drawn considerable attention in a practical setting because it may a) be more cost-effective,

*To whom correspondence should be addressed.
E-mail: nakataa-tky@umin.ac.jp, nakataa@health.uoeh-u.ac.jp

b) contain more face validity, c) be more acceptable and feasible by management/employers because it requires less time away from work tasks, and d) be suitable to measure changes in levels of job satisfaction[4–6]. According to a meta-analysis of single-item measures of global job satisfaction (28 correlations from 17 studies with 7,682 people), Wanous *et al.* (1997) demonstrated that single-item measures correlated quite highly with multi-item scales with a mean corrected correlation of r=0.67[5]; the study also found that differences in single-item measures had no effect on the meta-analysis results while differences in the ways that scales were measured did make a difference in results. On the basis of such observation, authors concluded that single-item measures are more robust than the scale measures of global job satisfaction. To further strengthen the validity of single-item global job satisfaction measure, objective outcomes such as its relationship with biomarkers are desired.

To date, several studies have evaluated the validity of multi-item job satisfaction scales based on its association with immune responses[7–11]. A study of Norwegian female nurses found that a sum of facet-specific job satisfaction (a total of 33 items) consisting of comfort, challenge, financial rewards, relations with coworkers, and resource adequacy and promotions, significantly associated with decreased circulating immunoglobulin (Ig) A and complement component C3[9]. A study of Israeli employees revealed that facet-specific job satisfaction scale (9 items) was inversely correlated with C-reactive protein (CRP) levels in men but not in women[10]. In contrast, global job satisfaction (3 items) was inversely correlated with serum interleukin (IL)-6 in women but not in men in a sample of Swedish employees[11]. More recently, a 1 yr prospective study of job stress and immunity among nurses (74% women) found that those who experienced a decrease in job satisfaction (19 items) had increased levels of IL-1β, IL-6, and CD8+CD57+ T cells, and a decreased level of interferon (IFN)-γ [8]. Our previous study in a sample of white-collar employees (165 men and 141 women) revealed that greater global job satisfaction (4 items) was positively correlated with NK cell cytotoxicity (NKCC) in both women and men while the number of NK (CD3-CD56+) cells was significantly correlated with job satisfaction in women only[7]. To the best of our knowledge, there are no study that examined the relationship between single-item global job satisfaction measure and immune indicators.

While job satisfaction has been extensively studied in various occupations, family life (non-work) satisfaction which constitutes the other spheres of life, has not received much attention in relation to immune functioning. We could not identify any studies directly associating family life satisfaction and immunity, however, a study among non-working community-dwelling elderly women reported that those who were satisfied with their life had significantly higher counts of NK cells and an insignificant increase of NKCC compared to the unsatisfied counterparts[12]. Thus to know which area of satisfaction is more related to immunity in healthy working people, it seems important to examine the independent association of job and family life satisfaction simultaneously.

Therefore, the purpose of this study was to evaluate the validity of single-item global job and family life satisfaction based on its association with cellular and humoral immune indices. We measured circulating NK (CD3-CD56+) cells, B (CD19+) and total T (CD3+CD56-) cells together with plasma immunoglobulin IgG concentrations among 189 white-collar employees.

Subjects and Methods

The study was conducted as a part of annual occupational health examination in April 2002. All participants were full-time, white-collar, and daytime Japanese employees working at a trading company (working between 9 a.m. to 5 p.m., Monday through Friday). Employees were not engaged in any type of shift work (e.g. rotating, night, evening) and were not working on weekends unless employees had particular reasons to work on weekends/non-workdays. A total of 217 employees who underwent health examination were invited to participate in this study and the survey questionnaire, including purpose, instruction, and informed consent was given to them. The completed questionnaires were returned prior to or on the day of the blood sampling. Overall, 216 employees agreed to participate in the questionnaire survey and blood test, and replied with a signed consent form. Of these employees, 17 were excluded because of missing data in essential study parameters. An additional 10 employees reporting physical/mental disorders related to immune alteration or under immunosuppresive medications were excluded (see 'Covariates' section for detail), which resulted in a sample of 189 participants. Participants were not exposed to known hazardous chemicals (i.e., benzene, benzidine, chromates, lead, mercury, organic solvents) that could affect immunological outcomes. The study protocol was reviewed and approved by the Institutional Review Board of the National Institute of Occupational Safety and

Health, Japan and by the Ethical Committee of the Kyushu University.

Job and family life satisfaction

Job and family satisfaction was measured individually by a single-item assessment tool, that is, whether or not the participant was satisfied with his/her a) current job and b) family life. Satisfaction items were scored on a four-point Likert scale with an option of 1) satisfied, 2) fairly satisfied, 3) fairly dissatisfied, and 4) dissatisfied. It was reversely scored so that higher score indicates a higher level of satisfaction. These items were taken from the Brief Job Stress Questionnaire, which was developed with a research grant for Japanese Ministry of Labor[13]. The items have been frequently used in past studies to measure job and family satisfaction at the workplaces[14–16]. The test-retest stability over 1 yr with job and life satisfaction was r_s=0.468 and r_s=0.567, respectively (p<0.001).

Preparation of blood samples

Fasting blood samples were collected between 9.00 and 11.00 a.m. from participants to control for diurnal variations. Ethylenediaminetetraacetic acid dipotassium (2 K-EDTA) was used as an anticoagulant to collect 2 ml of venous blood from subjects for the measurement of leukocytes counts, immunofluorescence staining, and plasma IgG. All samples were transported and handled at room temperature (i.e., 15–20°C). Immunofluorescence staining analysis was conducted within 24 h of blood collection. We determined counts of total leukocytes and total lymphocytes by an automated cell counter (Coulter Counter SP-VI, Coulter Electronics, Hialeah, Florida, USA), lymphocyte subpopulations by flow cytometry analysis (EPICS XL, Beckman Coulter Inc, California, U.S.A.), and plasma IgG concentration by Turbidimetric Immunoassay (Hitachi automatic analyzer 7150, Tokyo, Japan), as described in detail elsewhere[7, 17–20].

Cell surface marker analysis

The following sets of monoclonal antibodies were used to perform four-color direct immunofluorescence surface-marker analysis: anti-CD45-FITC / anti-CD56-RD1 / anti-CD19-ECD / anti-CD3-PC5. Anti-CD45-FITC antibody was used to identify and differentiate lymphocytes from non-lymphocytes and debris. A combination of Mouse IgG1-FITC / Mouse IgG1-RD1 / Mouse IgG1-ECD / Mouse IgG1-PC5 was used as the negative control. All monoclonal antibodies were purchased from Beckman Coulter Inc, USA. We calculated the number in each lymphocyte subset by multiplying lymphocyte counts by the percentage of positive cells in each category, as determined by flow cytometer (EPICS XL, Beckman Coulter Inc, Fullerton, CA, USA).

With regard to functional roles of selected lymphocytes, T and B cells bear central roles in cellular and humoral immunity; subsets of T (CD4+ and CD8+) cells control production of immunoglobulins from B cells and secretion of cytokines. NK cells are large granular cells possessing killer activity against certain tumor cells and virus-infected cells without prior sensitization. Although interpretation of changes in number of lymphocyte subsets needs great care, an excessive increase of T cells is known to be associated with systemic inflammation, whereas a persistent decrease of T cells is related to immunodeficiency[21]. Similarly, an extreme decrease of B cells is associated with suppressed humoral immune function resulting in inhibited production of immunoglobulins such as IgG, while a decrease of NK cells is associated with reduced effectiveness in killing infected and cancerous cells[22].

Covariates

Covariates included sex, age, education (in years), marital status (unmarried/married), smoking (number of cigarettes smoked per day), alcohol consumption (g ethanol intake/week), leisure-time physical activity, daily sleep duration, height, weight, typical work hours per day, job position (supervisor or non-supervisor), chronic condition, and regular medication usage. Alcohol consumption was estimated by asking the usual amount of alcoholic drinks consumed per day multiplied by the number of occasions in a week that alcoholic drinks were consumed and divided by seven. We assessed leisure-time physical activity by calculating the energy expenditure of habitual physical exercise. We asked frequency, type, and length of physical exercise per month and converted these data to metabolic equivalents (METs)[23]. Usual daily sleep duration was calculated as a weighted average of weekday and weekend sleep durations (hrs) using the following formula: ([{usual weekday sleep duration}×5] + [{usual weekend sleep duration}×2])/7[18] and the following question was used: On average, when do you start sleeping and when do you wake up in the morning in weekdays (workdays) and weekends (non-work days), respectively? Height (m) and weight (kg) were measured anthropometrically to assess body mass index (BMI), calculated as weight in kilograms divided by the square of height in meters.

Regarding chronic condition, participants were interviewed by occupational health doctors/nurses if they had

been diagnosed or being treated for any of the following symptoms or disorders at the time of the study: hypertension, diabetes mellitus, depression, asthma, allergies, cancer, angina pectoris, cardiac infarction, gout, renal disease, colonic polyp, skin disease, anxiety disorders, musculoskeletal disorders, arrhythmia, cholelithiasis, kidney and urinary track diseases, liver disease, cerebrovascular disease, hyperlipidemia, gastric/duodenal ulcer, autonomic imbalance, or other diseases. If the subjects reported 'other diseases,' they were asked to specify the condition. Participants with immune-related disorders, i.e., gastric/duodenal ulcer, asthma, severe allergies, and the common cold as well as those who reported pregnancy were excluded from the analyses (n=8). The number of other disorders was counted and included as a covariate (no=0, yes=1). We also obtained data on the use of medications; those using drugs potentially immunosuppressive, i.e., β-blockers, corticosteroids, antidepressants, or anxiolytics, were excluded (n=2).

Statistical analyses

Intercorrelations between job and family life satisfaction with immune indices were initially tested by the Spearman rank correlation coefficient since satisfaction items were not normally distributed. Spearman's partial correlation analysis with incremental adjustments for covariates was used to examine the relationship between satisfaction items (independent variable) and immune indices (dependent variables). In Model 1, we entered sociodemographic (age, sex, education, and marital status) variables. In Model 2, we added behavioral (smoking, alcohol consumption, physical activity, and daily sleeping duration) factors in addition to model 1 variables. And in the final model (Model 3), we added biological (BMI and chronic condition) and other occupational (work hours and job position) factors in addition to model 2 variables.

We have tested the combined effects of job and family life satisfaction on immune indices and participants were divided into four groups; those who reported low (dissatisfied/fairly dissatisfied) job satisfaction and low family satisfaction (Group 1, n=14), high (satisfied/fairly satisfied) job satisfaction and low family satisfaction (Group 2, n=7), low job satisfaction and high family satisfaction (n=42) (Group 3, n=49), and high job satisfaction/high family satisfaction (Group 4, n=126). Because the number of participants in Group 2 was relatively small (n=7), we have further conducted analyses combining Groups 2 and 3 together.

Differences in the numbers of lymphocyte subsets and plasma IgG concentrations between the groups were tested by the analysis of covariance with sociodemographic, behavioral, biological, and occupational variables as covariates. The significance level for all statistical analyses was set at $p<0.05$ (two-tailed test). We analyzed the data using the SAS version 9.2 (SAS Institute, Inc., Cary, North Carolina, USA).

Table 1. Characteristics of study participants (n=189)[a]

Characteristics:	Mean ± SD or n (%)
Job satisfaction:[b]	2.76 ± 0.80
Satisfied	*27 (14.3)*
Fairly satisfied	*106 (56.1)*
Fairly dissatisfied	*40 (21.2)*
Dissatisfied	*16 (8.5)*
Family satisfaction:[b]	3.19 ± 0.67
Satisfied	*60 (31.7)*
Fairly satisfied	*108 (57.1)*
Fairly dissatisfied	*18 (9.5)*
Dissatisfied	*3 (1.6)*
Sex, % men	*133 (70.4)*
Age (in years)	41.7 ± 11.6
Education (in years)	15.2 ± 1.6
Marital status, % married	*120 (63.5)*
Smoking (number of cigarettes smoked/day)	8.0 ± 12.4
Alcohol consumption (g ethanol/week)	146.6 ± 145.3
Leisure-time physical activity (METs/week)	5.8 ± 9.2
Daily sleep duration[b]	7.1 ± 0.8
BMI (kg/height (m)^2)	22.7 ± 3.0
Chronic condition (yes)	*33 (17.5)*
Work hours/day	9.7 ± 1.8
Job position (supervisor)	*45 (23.8)*
Immune indicators:	
NK (CD3-CD56+) cells (cells/mm^3)	314 ± 195
Total T (CD3+CD56-) cells (cells/mm^3)	1,159 ± 415
B (CD19+) cells (cells/mm^3)	252 ± 143
Plasma IgG (mg/dl)	1,138 ± 205

[a]Participants who reported immune-related disorders were excluded to eliminate the potential effects of health status on immune parameters. [b]Positively oriented (1=dissatisfied, 4=satisfied).

Results

Sample characteristics

Characteristics of study participants are shown in Table 1. On balance, more than 70% were satisfied with their job and 89% were satisfied with their family life. About 70% were men and 64% were married. On average, participants aged 42 yr, educated 15 yr, and worked 9.7 h per day. No participants in this sample showed clinically overt abnormalities of immune indicators.

Table 2. Spearman rank correlation between satisfaction items and immune indices (n=189)

Variable	1		2		3		4		5	
	r_s	*p*	r_s	*p*	r_s	*p*	r_s	*p*	r_s	*p*
1. Job satisfaction (1=dissatisfied, 4=satisfied)	–	–								
2. Family satisfaction (1=dissatisfied, 4=satisfied)	**0.353**	***<0.001***	–	–						
3. NK (CD3–CD56+) cells (cells/mm^3)	**0.200**	***0.006***	0.040	*0.588*	–	–				
4. T (CD3+CD56–) cells (cells/mm^3)	0.007	*0.922*	0.019	*0.791*	–0.061	*0.405*	–	–		
5. B (CD19+) cells (cells/mm^3)	–0.106	*0.148*	–0.069	*0.347*	–0.054	*0.463*	**0.299**	***<.001***	–	–
6. Plasma IgG (mg/dl)	**0.212**	***0.003***	0.073	*0.320*	–0.067	*0.363*	0.104	*0.153*	0.069	*0.349*

Spearman rank correlation between job and family satisfaction and immune indices

Intercorrelations between job and family satisfaction with immune indices are shown in Table 2. Correlation between job and family satisfaction was moderate (*rs*=0.353). Job satisfaction was significantly and positively correlated with NK cells and IgG concentrations but was unrelated to total T or B cells. Family satisfaction was not associated with any immunological indices.

Spearman's partial correlation between job and family satisfaction and immune indices

Spearman's partial correlations controlling for different levels of covariates are shown in Table 3. Job satisfaction was consistently correlated with NK cells and IgG concentrations in three different models. The relationship between job satisfaction and NK cells was strengthened after controlling for covariates while its association with plasma IgG was attenuated but remained significant. Job satisfaction was inversely but marginally correlated with B cells (model 1) but was not associated with total T cells. Family satisfaction was not correlated with any immunological indices.

Combined association of job and family satisfaction with immune indices

When the analyses were conducted in four groups, no significant differences in immune indices were found between the groups (data not shown). However, when combining Groups 2 and 3 together (new Group 2), the group differences became more apparent (Fig. 1). Group 1 participants had significantly lower NK cell (Fig. 1-a) and higher B cell counts (Fig. 1-c) than Group 3 participants; total T cell counts (Fig. 1-b) and plasma IgG concentrations (Fig. 1-d) did not show any significant differences between Groups 1 and 3. Group 2 participants had significantly lower NK cell counts than Group 1 participants (Fig. 1-a). In contrast, Group 1 participants had significantly increased total T (Fig. 1-b) and B cell counts (Fig. 1-c) than Group 2 participants. Although a trend has been observed, there were no significant differences in plasma IgG concentrations between Groups 1, 2 and 3 (Fig. 1-d).

Discussion

The purpose of this study was to evaluate the association of single-item job and family satisfaction measures with cellular and humoral immune indices in a sample of white-collar employees. There were three main findings from this study. First, job satisfaction was consistently associated with NK cells and plasma IgG concentrations while family satisfaction was not related to any immunological indices. Second, combination of job and family satisfaction analysis indicated that those who were dissatisfied with their job and family life (Group 1) had significantly lower NK cells but higher B cells than those satisfied with their job and family life (Group 3). In addition, T and B cell counts were significantly higher in Group 3 than those who were only satisfied with their job or family life (Group 2); Group 3 had significantly higher NK cell counts than Group 2. Finally, job and family satisfaction had a moderate association, suggesting that satisfaction in one area of one's life spills over or generalizes to another to some degree. Our study suggests that the single-item summary measure of job satisfaction, but not family life satisfaction, may be a valid tool to detect immune alterations among workers.

Several past studies have explored the relationship between job satisfaction and immune responses by multi-item job satisfaction scales as described earlier[7–11]. These studies found that workers who maintained low job satisfaction levels had worse immune status than those who had not, as evidenced by higher levels of proinflammatory markers and lower NK cell immunity. The result of this study is also in line with past researches which reported that exposure to high job stress is associated with reduc-

Table 3. Summary of Spearman's partial correlations controlling for different levels of covariates (n=189)

	Job satisfaction[a]		Family satisfaction[a]	
	r_{sp}	p	r_{sp}	p
Model 1[b]				
NK (CD3–CD56+) cells (cells/mm^3)	**0.183**	**0.013**	0.029	0.691
T (CD3+CD56–) cells (cells/mm^3)	0.008	0.911	0.017	0.815
B (CD19+) cells (cells/mm^3)	–0.137	0.064	–0.092	0.214
Plasma IgG (mg/dl)	**0.227**	**0.002**	0.071	0.335
Model 2[c]				
NK (CD3–CD56+) cells (cells/mm^3)	**0.194**	**0.009**	–0.009	0.909
T (CD3+CD56–) cells (cells/mm^3)	0.051	0.499	0.063	0.398
B (CD19+) cells (cells/mm^3)	–0.114	0.125	–0.062	0.410
Plasma IgG (mg/dl)	**0.215**	**0.004**	0.059	0.429
Model 3[d]				
NK (CD3–CD56+) cells (cells/mm^3)	**0.201**	**0.007**	–0.021	0.782
T (CD3+CD56–) cells (cells/mm^3)	0.039	0.604	0.056	0.462
B (CD19+) cells (cells/mm^3)	–0.116	0.124	–0.080	0.293
Plasma IgG (mg/dl)	**0.178**	**0.018**	0.050	0.510

[a]Positively oriented (1=dissatisfied, 4=satisfied). [b]Adjusted for sex, age, education, and marital status. [c]Adjusted for sex, age, education, marital status, smoking, alcohol consumption, physical activity, daily sleep duration. [d]Adjusted for sex, age, education, marital status, smoking, alcohol consumption, physical activity, daily sleep duration, BMI, chronic condition, work hours, and job position.

tion of NK cells and NKCC[19, 24–28] as well as increased proinflammatory markers such as CRP, IL-6, total leukocytes, and B cells among variety of occupations[20, 29–31]. As a result of exposure to chronic job stress, employees may become more dissatisfied with their work manifesting immune disruption.

No direct association between family life satisfaction and immune parameters was found in this study. The negative finding may be interpreted as follows. Employees in this study are generally working actively and intensively and their pleasure and satisfaction may be earned through their job rather than their personal life, i.e., family, hobby, etc. In contrast, as reported by Tsuboi *et al.* (2005), those who are retired or nonworking may earn their satisfaction through their daily personal life[12]. In such cases, satisfaction to one's personal life may be a source that influences NK cell immunity. Taken together, it is speculated that 'satisfaction' is associated with immune functioning but it may depend on the context and nature of the target population.

In the three group analyses, combined association of job and family satisfaction suggested that those who were satisfied with their job and family life had maintained higher NK cells and lower B cells compared to those with low job and low family satisfaction; the number of total T cells was also highest in the low job/low family satisfaction combination (Fig. 1). Interestingly, in Group 2, numbers of NK and B cells as well as plasma IgG concentrations were placed in the middle of low/low and high/high combinations, suggesting a dose-dependent relationship with satisfaction levels. However, a caution is needed when interpreting the results since we did not find clear differences in immune indices when the analyses were conducted in four groups which may possibly be due to a small sample size in Group 2 (n=7). Reduced NK cells and IgG by low satisfaction levels could be considered an immunosuppressive effect of stress while increased B and T cells may be a result of inflammatory responses or compensation to reduced NK cells/IgG.

A moderate association between job and family satisfaction was found in this study (r=0.353). According to a meta-analytic review based on 34 studies of job and life satisfaction relationship, Tait *et al.* (1989) observed a mean uncorrected correlation between job and life satisfaction to be r=0.35 and corrected correlation to be r=0.44[32], suggesting that job experiences may spill over onto other spheres of life. However, to clarify the precise mechanisms of how job and family satisfaction are related

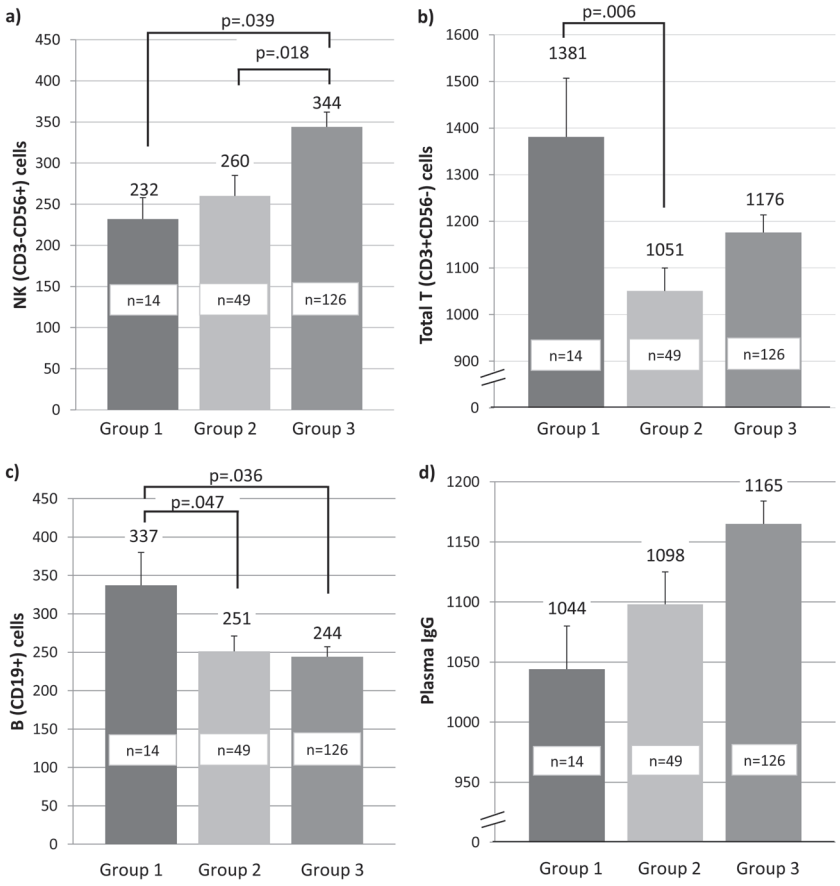

Fig. 1. Combined associations of job satisfaction and family satisfaction on cellular and humoral immune indices.

Group 1: Low job satisfaction / Low family life satisfaction (n=14); Group 2: Low job satisfaction / High family life satisfaction or High job satisfaction / Low family life satisfaction (n=49); and Group 3: High job satisfaction / High family life satisfaction (n=126).

to each other and affects immune function, it is necessary to conduct further studies in a prospective design.

In this study, we measured quantity (i.e., NK cell counts) rather than function (i.e., NKCC) of NK cells to explore the effects of job/family life satisfaction on immunity. The reason why we chose this methodology can be explained as follows. First, the count of NK cells is highly correlated with NKCC and changes in cytolytic activity are determined to a great extent by changes in NK cell counts in cross-section[7, 18, 33, 34] and in a prospective manner[19]. Second, it is also possible to measure 'subsets' of NK cells based on their prevalence and function. For example, $CD56^{dim}$+ cells hold high cytoxic capacity while $CD56^{bright}$+ maintain higher affinity for IL-2 and a large capacity to produce cytokines such as Tumor Necrosis Factor-β, IL-10, IL-13, and Interferon-γ after monokine stimulation[35, 36]. Third, in a practical manner, we think that measuring lymphocyte subsets (including NK cell) are more convenient and feasible for occupational epidemiology studies like this since we could obtain abundant information (such as numbers of T, B, NK cells, etc.) simultaneously with a short period of time[37].

Strengths and limitations of the study

This study has strengths and limitations that should be considered for the interpretation of the results. The specific strengths of our study are that we controlled for a broad array of potential confounders and measured both job and family satisfaction concurrently. Most job satisfaction research has not considered 'non-work' or 'family life' satisfaction simultaneously which may cover two major spheres of life satisfaction. In addition, participants who were diagnosed with disorders that are known to affect immune outcomes were excluded to minimize sampling bias, i.e., reduced satisfaction or altered immune status as a consequence of health conditions. Several limitations to this study should be noted. First, since this study is of

cross-sectional data, the association could be in either direction, i.e., job satisfaction may increase NK cells and IgG immune status − or that increased NK cells and/or IgG concentrations may be the cause for heightened job satisfaction. Second, using a convenience sample of a Japanese trading company limits the generalizability of the findings to other work settings or workers of other racial/ethnic groups. Third, the sample size was not large, which might have contributed to underestimation of effect size, i.e., family life satisfaction and immune indices. Fourth, it is also important to note that the job and family life satisfaction items used in this study showed relatively low test-retest stability which points to a potential limitation. Fifth, it is not clear how reliably the single-item measure will capture job/family satisfaction levels when administered in other formats; face-to-face interview, telephone interview, or via the web interface. And finally, even though we adjusted for a variety of confounders, we could not exclude the possibility that unadjusted factors, i.e., personality traits, genetic components, menstrual phase or oral contraceptive use, other social/occupational factors, as well as unknown/unmeasured factors may have affected our findings.

Conclusion

This study examined the association between single-item job and family life satisfaction measures with cellular and humoral immune status in a sample of 189 healthy Japanese white-collar daytime employees. The results revealed that single-item job satisfaction is associated with increased NK cell counts and plasma IgG concentrations. This measure may be a valid and convenient tool to evaluate psychosocial work condition influencing immune status compared to more lengthy and time-consuming measures. Further research is needed to confirm the relationships between satisfaction, immunity, and long-term health outcomes in a prospective manner.

Acknowledgements

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the US National Institute for Occupational Safety and Health. Authors are grateful to Dr. Kaori Fujishiro, PhD of the National Institute for Occupational Safety and Health for her help with statistical analyses.

References

1) Bowling NS (2010) A meta-analytic examination of the relationship between job satisfaction and subjective well-being. J Occup Organ Psychol **83**, 915–34.
2) Faragher EB, Cass M, Cooper CL (2005) The relationship between job satisfaction and health: a meta-analysis. Occup Environ Med **62**, 105–12.
3) van Saane N, Sluiter JK, Verbeek JH, Frings-Dresen MH (2003) Reliability and validity of instruments measuring job satisfaction—a systematic review. Occup Med (Lond) **53**, 191–200.
4) Dolbier CL, Webster JA, McCalister KT, Mallon MW, Steinhardt MA (2005) Reliability and validity of a single-item measure of job satisfaction. Am J Health Promot **19**, 194–8.
5) Wanous JP, Reichers AE, Hudy MJ (1997) Overall job satisfaction: how good are single-item measures? J Appl Psychol **82**, 247–52.
6) Nagy MS (2002) Using a single-item approach to measure facet job satisfaction. J Occup Organ Psychol **75**, 77–86.
7) Nakata A, Takahashi M, Irie M, Swanson NG (2010) Job satisfaction is associated with elevated natural killer cell immunity among healthy white-collar employees. Brain Behav Immun **24**, 1268–75.
8) Amati M, Tomasetti M, Ciuccarelli M, Mariotti L, Tarquini LM, Bracci M, Baldassari M, Balducci C, Alleva R, Borghi B, Mocchegiani E, Copertaro A, Santarelli L (2010) Relationship of job satisfaction, psychological distress and stress-related biological parameters among healthy nurses: a longitudinal study. J Occup Health **52**, 31–8.
9) Endresen IM, Vaernes R, Ursin H, Tonder O (1987) Psychological stress-factors and concentration of immunoglobulins and complement components in Norwegian nurses. Work Stress **1**, 365–75.
10) Shirom A, Toker S, Berliner S, Shapir I, Melamed S (2006) Work-related vigor and job satisfaction relationships with inflammation biomarkers among employed adults. In: Dimensions of well-being: research and intervention, Fave AD (Ed.), 254–74, Franco Angeli, Milano.
11) Theorell T, Hasselhorn HM, Vingard E, Andersson B, MUSIC-Norrtalje-Study-Group (2000) Interleukin 6 and cortisol in acute musculoskeletal disorders: results from a case-referent study in Sweden. Stress Med **16**, 27–35.
12) Tsuboi H, Kawamura N, Hori R, Kobayashi F, Iwasaki Y, Takeuchi H, Fukino O (2005) Depressive symptoms and life satisfaction in elderly women are associated with natural killer cell number and cytotoxicity. Int J Behav Med **12**, 236–43.
13) Shimomitsu T, Yokoyama K, Ono Y, Maruta T, Tanigawa T (1998). Development of a novel brief job stress questionnaire. In: Report of the Research Grant of a Prevention of Work-Related Diseases from the Ministry of Labour, Kato M (Ed.), 107–15, Tokyo Medical University, Tokyo (in Japanese).

14) Sato Y, Miyake H, Theriault G (2009) Overtime work and stress response in a group of Japanese workers. Occup Med (Lond) **59**, 14–9.
15) Kawada T, Otsuka T (2011) Relationship between job stress, occupational position and job satisfaction using a brief job stress questionnaire (BJSQ). Work **40**, 393–9.
16) Shimazu A, de Jonge J (2009) Reciprocal relations between effort-reward imbalance at work and adverse health: a three-wave panel survey. Soc Sci Med **68**, 60–8.
17) Nakata A, Irie M, Takahashi M (2011) Association of general fatigue with cellular immune indicators among healthy white-collar employees. J Occup Environ Med **53**, 1078–86.
18) Nakata A, Takahashi M, Irie M (2012) Association of overtime work with cellular immune markers among healthy daytime white-collar employees. Scand J Work Environ Health **38**, 56–64.
19) Nakata A, Irie M, Takahashi M (2011) Psychological distress, depressive symptoms, and cellular immunity among healthy individuals: a 1-year prospective study. Int J Psychophysiol **81**, 191–7.
20) Nakata A, Takahashi M, Irie M (2011) Effort-reward imbalance, overcommitment, and cellular immune measures among white-collar employees. Biol Psychol **88**, 270–9.
21) Westermann J, Pabst R (1990) Lymphocyte subsets in the blood: a diagnostic window on the lymphoid system? Immunol Today **11**, 406–10.
22) Whiteside TL, Herberman RB (1994) Role of human natural killer cells in health and disease. Clin Diagn Lab Immunol **1**, 125–33.
23) Suzuki I, Kawakami N, Shimizu H (1998) Reliability and validity of a questionnaire for assessment of energy expenditure and physical activity in epidemiological studies. J Epidemiol **8**, 152–9.
24) Morikawa Y, Kitaoka-Higashiguchi K, Tanimoto C, Hayashi M, Oketani R, Miura K, Nishijo M, Nakagawa H (2005) A cross-sectional study on the relationship of job stress with natural killer cell activity and natural killer cell subsets among healthy nurses. J Occup Health **47**, 378–83.
25) Nakata A, Araki S, Tanigawa T, Miki A, Sakurai S, Kawakami N, Yokoyama K, Yokoyama M (2000) Decrease of suppressor-inducer (CD4+ CD45RA) T lymphocytes and increase of serum immunoglobulin G due to perceived job stress in Japanese nuclear electric power plant workers. J Occup Environ Med **42**, 143–50.
26) Boscolo P, Di Donato A, Di Giampaolo L, Forcella L, Reale M, Dadorante V, Alparone F, Pagliaro S, Kouri M, Magrini A, Fattorini E (2009) Blood natural killer activity is reduced in men with occupational stress and job insecurity working in a university. Int Arch Occup Environ Health **82**, 787–94.
27) De Gucht V, Fischler B, Demanet C (1999) Immune dysfunction associated with chronic professional stress in nurses. Psychiatry Res **85**, 105–11.
28) Cohen F, Kemeny ME, Zegans LS, Johnson P, Kearney KA, Stites DP (2007) Immune function declines with unemployment and recovers after stressor termination. Psychosom Med **69**, 225–34.
29) Almadi T, Cathers I, Hamdan Mansour AM, Chow CM (2012) The association between work stress and inflammatory biomarkers in Jordanian male workers. Psychophysiology **49**, 172–7.
30) Schnorpfeil P, Noll A, Schulze R, Ehlert U, Frey K, Fischer JE (2003) Allostatic load and work conditions. Soc Sci Med **57**, 647–56.
31) Miyazaki T, Ishikawa T, Nakata A, Sakurai T, Miki A, Fujita O, Kobayashi F, Haratani T, Iimori H, Sakami S, Fujioka Y, Kawamura N (2005) Association between perceived social support and Th1 dominance. Biol Psychol **70**, 30–7.
32) Tait M, Padgett MY, Baldwin TT (1989) Job and life satisfaction: a reevaluation of the strength of the relationship and gender effects as a function of the date of the study. J Appl Psychol **74**, 502–7.
33) Vedhara K, Fox JD, Wang EC (1999) The measurement of stress-related immune dysfunction in psychoneuroimmunology. Neurosci Biobehav Rev **23**, 699–715.
34) Bellingrath S, Rohleder N, Kudielka BM (2010) Healthy working school teachers with high effort-reward-imbalance and overcommitment show increased pro-inflammatory immune activity and a dampened innate immune defence. Brain Behav Immun **24**, 1332–9.
35) Cooper MA, Fehniger TA, Caligiuri MA (2001) The biology of human natural killer-cell subsets. Trends Immunol **22**, 633–40.
36) Cooper MA, Fehniger TA, Turner SC, Chen KS, Ghaheri BA, Ghayur T, Carson WE, Caligiuri MA (2001) Human natural killer cells: a unique innate immunoregulatory role for the CD56(bright) subset. Blood **97**, 3146–51.
37) Nakata A, Tanigawa T, Araki S, Sakurai S, Iso H (2004) Lymphocyte subpopulations among passive smokers. JAMA **291**, 1699–700.