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# BMJ Open

## Health Literacy and Quality of Life Among Cancer Survivors in China

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-028458
Article Type:	Research
Date Submitted by the Author:	11-Dec-2018
Complete List of Authors:	Xia, Juan; Fudan University, school of public health Deng, Qinglong; Fudan University, school of public health Yan, Rui; Fudan University, school of public health Wu, Peng; Fudan University, school of public health Yang, Renren; Fudan University, school of public health Lv, Binghui; Fudan University, school of public health Wang, Jiwei; Fudan University, Fudan university school of public health Yu, Jinming; Fudan University, school of public health
Keywords:	Health Literacy, 3 Brief Questions, Quality of Life, Cancer Survivors

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Manuscripts

**Title Page**

**Title:** Health Literacy and Quality of Life Among Cancer Survivors in China

**Running title:** Health Literacy and QOL in Cancer

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**Manuscript word count:** 2385 words

**Numbers of references:** 32

**Numbers of tables and figures:** 3 tables and 2 figure

**Abstract word count:** 262 words

**Key words:** Health Literacy; 3 Brief Questions; Quality of Life; Cancer Survivors

**Conflict of interest statement:** The authors declare no potential conflicts of interest.

## Health Literacy and Quality of Life Among Cancer Survivors in China

**Objective** To evaluate the association between Health Literacy (HL) and Quality of Life (QOL) among Cancer Survivors in China.

**Design** Cross-sectional observational study in China.

**Setting and participants** Cross-sectional observational study of 4713 cancer survivors who were older than 18 years and had cancers come from the Shanghai Cancer Rehabilitation Club. Participants were enrolled and completed questionnaires between May and July 2017.

**Main measures** We assessed participants' HL by using 3 established screening questions. Participants were excluded if they did not complete at least 1 HL question. Item Response Theory (IRT) was used to evaluate the existing measure of health literacy. Scores were summed, and participants were categorized as low HL if their total score was greater than 10 and adequate HL if it was 10 or lower.

**Results** Of the 4173 participants surveyed, 4610 responded (97.8% response rate). IRT scaling parameters of the health literacy measure found items had a good range of discriminating and difficulty. Of 4589 included responders, 159 (3.5%) had low HL. After adjusting for participants' sociodemographic characteristics, social support, treatment regimen, and years with cancers, for each 1-point decrement in HL score, the QOL score increased by 2.07 ( $P < .0001$ ). Cancer survivors with low HL were less likely than survivors with adequate HL to achieve a better QOL. In logistic regression, low HL was independently associated with poor QOL (adjusted odds ratio, 2.81 [95% confidence interval], 1.94-4.06 ;  $P < .001$ ).

**Conclusions** Among cancer survivors in Shanghai Cancer Rehabilitation Club, low HL was independently associated with poor QOL.

**Key words:** Health Literacy; 3 Brief Questions; Quality of Life; Cancer Survivors

## Article summary

- Cancer survivors with adequate Health Literacy had nearly 3 times the odds of having a better Quality of Life than cancer survivors with inadequate Health Literacy.
- Improving cancer survivors' health literacy might be an important targets for improving their QOL.

## Strengths and limitations of this study

- To the best of our knowledge, this is the first study using 3 brief screening questions to evaluate Chinese cancer survivors' health literacy instead of the complex and long questions which are not suitable to use in clinical routine practice, and to explore its relationship with quality of life.
- Item response theory was used to evaluate whether a summed unidimensional health literacy scale could be used.
- Causal inferences could not be allowed due to the cross-sectional design.

## Introduction

Health literacy (HL) is an evolving concept. As defined by the National Library of Medicine(1), HL is “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions.” It means more than simply the ability to “read pamphlets”, “make appointments”, “understand food labels” or “comply with prescribed actions” from a doctor(2). Higher levers of HL within populations yield social benefits(3, 4), and HL is an important factor in ensuring significant health outcomes(5, 6).

Cancer is one of the leading causes of morbidity and mortality worldwide(7). The economic impact of cancer is significant and increasing. Quality of Life (QOL) has been increasingly used as a comprehensive health indicator in clinical treatment and interventions(8). Little is known about the association between HL and QOL among cancer survivors. Isolating the independent contribution of HL toward cancer survivors' QOL would have an important clinical and public

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4 health implications. A growing body of research measured HL with complex and long questions which are not suitable to  
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6 use in clinical routine practice (9). Therefore, the purpose of this study was to evaluate the association between HL and  
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8 QOL among cancer survivors in Shanghai Cancer Rehabilitation Club using 3 brief screening questions.  
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## 11 12 **METHODS**

### 13 14 15 **Patient and Public Involvement**

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17 All participants were enrolled in Shanghai Cancer Rehabilitation Club, a nongovernmental self-help mutual aid  
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19 organization that contains of 20 members of the branch offices, 175 community block group, and more than 13,000  
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21 members. The study covered 16 districts in Shanghai (Huangpu, Pudong, Xuhui, Changning, Putuo, Hongkou, Yangpu,  
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23 Minhang, Baoshan, Jiading, Jinshan, Songjiang, Qingpu, Fengxian, Chongming and Jingan).  
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28 Participants were eligible if they were older than 18 years, diagnosed with cancers, cured or uncured, with or without  
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30 complications. Participants had to have read ability. We excluded participants with any documented billing diagnosis of  
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32 psychotic disorder, dementia, or blindness (conditions that may interfere with accurate health literacy measurement).  
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37 Between May and July 2017, investigators were trained and field investigation was conducted. Participants were asked  
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39 to participant in a survey and complete a questionnaire survey and were offered a box of eggs for their participation.  
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41 Informed consent was obtained from survivors before enrollment. The protocol was approved by the committee of Public  
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43 Health School of Fudan University (protocol number IRB # 2017-05-0621).  
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### 47 48 **Measures**

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50 HL was assessed using 3 established screening questions and categorized as adequate or inadequate (10-13). The  
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52 screening questions, respectively, were Item1: "How often do you have someone help you read hospital materials?", Item  
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54 2: "How confident are you filling out forms by yourself" and Item 3: "How often do you have problems learning about  
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56 your medical condition because of difficulty reading hospital materials?". Each question was scored by participants on a  
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4 5-point scale. HL was evaluated as a continuous and dichotomous variable. Based on prior literature(9), scores were  
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6 summed, and participants were categorized as low HL if their total score was greater than 10 and adequate HL if it was 10  
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8 or lower.  
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11 QOL was assessed using the simplified Chinese version of the quality-of-life questionnaire-core 30 items (EORTC QLQ-  
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13 30), which incorporates nine multi-item scales(14): five functional scales (physical, role, cognitive, emotional, and social  
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15 functioning), three symptom scales (fatigue, pain, and nausea/vomiting), and a global health status/QOL scale; and six  
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17 single-item scales (dyspnea, insomnia, appetite loss, constipation, diarrhea, and financial difficulties). The psychometric  
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19 properties of the questionnaire had been previously evaluated(15). Scale scores were calculated by averaging items within  
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21 scales and transforming average scores linearly. All of the scales range in score from 0 to 100. A high score for a functional  
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23 scale represents a high/healthy level of functioning whereas a high score for a symptom scale or item represents a high  
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25 level of symptomatology or problems. For more details on the scoring procedures see the EORTC QLQ-C30 Scoring  
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27 Manual(16). Participants were classified as having better QOL if their scores was higher than 50 and poor QOL if it was  
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29 lower than 50.  
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### 39 **Other variables**

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41 Covariates collected were age, sex, race/ethnicity, socioeconomic status, self-reported education level, marital status  
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43 (married vs single or divorced/widowed), insurance status, years with cancer, smoking habit, alcohol use, exercise, treatment  
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45 regimen, district, BMI and history of coexisting illnesses. Because coexisting illnesses may affect survivors QOL, we  
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47 measured coexisting illnesses conditions by asking cancer survivors whether they had ever been told by a physician that  
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49 they had chronic diseases, including hypertension, hyperlipemia, hyperuricemia, diabetes, heart disease, stroke, respiratory  
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51 disease, digestive system disease and skeleton system diseases. All covariates were determined at the time of the survey.  
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### 58 **Statistical Analysis**

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4 To determine whether a summed unidimensional health literacy scale could be used, item response theory (IRT) was  
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6 used to evaluate the item parameter (discrimination parameter, threshold parameter), item characteristic curve (ICC) and  
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8 item information curve (IIF). For the items were ordered responses, the Graded Response Model (GRM) was used. For the  
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10 participants answering only 1 or 2 of the 3 questions, the score for those questions was multiplied by 3 and 1.5, respectively  
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15 (9).

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17 Baseline characteristics were compared across levels of HL using  $\chi^2$  test for categorical variables and Wilcoxon test  
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19 for the non-normal continuous variables. Linear regression models were used to estimate the association between HL score  
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21 and QOL after controlling for differences in participants' characteristics, including age, sex, race/ethnicity, marriage,  
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23 education, income, insurance status, years with cancer, number of chronic disease, smoking habit, alcohol use, excise,  
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25 treatment regimen, district and BMI. Logistic regression models were used to measure the independent relationship  
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27 between HL and each of the QOL scales, while adjusting for other potentially confounding survivor characteristics.  
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34 The IRT analyses were conducted using the MULTILOG version 7.03. Other statistical analyses were performed with  
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36 SAS version 9.4 for each analysis, the null hypothesis was evaluated at a 2-sided significance levels of 0.05.  
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## 42 Results

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44 Among 4713 cancer survivors surveyed, 4610 responded, for a 97.81% response rate. For 4589 of the 4610 participants,  
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46 at least 1 HL question was available in the survey; these participants composed our study sample.  
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50 The summed HL scale was measured by using all 3 HL questions. The correlations of single items to the total were 0.73,  
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52 0.70, and 0.75 for questions 1 to 3, respectively. Figure 1 shows the IRT models and test information for the total sample  
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54 and illustrates the implications of the item parameters for the response probabilities for different levels of health literacy.  
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56 All items had high discrimination parameters, except for Item 3, 'How often do you have problems learning about your  
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4 medical condition because of difficulty reading hospital materials', which had a moderate discrimination ( $\alpha=0.88$ ) but still  
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6 satisfy the condition of  $\alpha>0.75$ . The difficulty parameters (Threshold<sub>i</sub>) increased monotonically across rating scale  
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8 categories for all items, ranging from -1.81 to 3.94, indicating that the 3 HL questions discriminate well. Among the 4589  
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10 participants in the study, the mean HL score was 6.3 (range, 3-15). As table 1 shows, one hundred fifty-nine participants  
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12 (3.5%) had low HL (HL score, 11-15). Participants with low HL were more likely than participants with adequate HL to  
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14 be older, to have received only some middle school education or less, and to have had little exercise.

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20 Table 2 presents the bivariate relationships between predictors of QOL and cancer survivors' global health status. The  
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22 HL score, age, sex, marriage, years with cancer, number of the chronic disease, smoking habit, alcohol use, exercise, district  
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24 and BMI were all associated with QL. After adjustment for other potentially confounding factors, marriage, years with  
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26 cancer, and smoking habit were no significant difference. For each 1-point decrement in HL score, the QL value increased  
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28 by 2.07 ( $P<.001$ ).

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34 Cancer survivors with adequate HL were more likely than cancer survivors with low HL to have a high score for a  
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36 functional scale whereas a low level of symptomatology. According to the recommendation(17), a difference on the 0–100  
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38 scale of more than 5 points were considered as a clinically important difference. As can be seen from the data in Figure 2  
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40 that there had a clinically significant difference between survivors with adequate HL and survivors with low HL, in terms  
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42 of global health status (difference of adequate HL vs low HL [diff], 9.05), role function (diff: 5.2), emotional function (diff:  
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44 5.17), cognitive function (diff: 7.13), social function (diff: 7.49), insomnia (diff: -8.8), and financial difficulties (diff: -  
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46 8.71).

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53 Eighty-three percent of cancer survivors with adequate HL and 65% of cancer survivors with low HL reported that they  
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55 had a good global health status (unadjusted odds ratio [OR], 2.75; 95% confidence interval [CI], 1.97-3.84;  $P<.001$ ). After  
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57 confounders were adjusted, cancer survivors with adequate HL were more likely to report a better global health status  
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4 (adjusted OR, 2.81; 95% CI, 1.94-4.06; P<.001) (Table 3). The extent of the associations between HL and other scales of  
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6 QOL, including four functional scales (physical, emotional, cognitive and social functioning), three symptom scales  
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8 (fatigue, pain, and nausea/vomiting), and three single-item (insomnia, appetite loss, and financial difficulties), was similar  
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12 to that of global health status and all had a statistical significance (Table 3).  
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## 14 15 **Discussion**

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17 Our study demonstrates that inadequate HL as assessed by 3 brief screening questions was present in less than 1 in 25  
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19 cancer survivors in Shanghai Cancer Rehabilitation Club. And inadequate HL was an independent predictor of poor QOL  
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21 and was associated with a lower level of functioning and higher level of symptomatology or problems. The association  
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23 between HL and QOL that we observed is significant from a clinical and public health perspective. These findings highlight  
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25 a potential target for interventions to improve the overall quality of life for cancer survivors.  
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31 To our knowledge, no prior study had demonstrated the association between HL and QOL among cancer survivors using  
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33 the 3 brief screening questions. Prior research studies have used more complex and extensive questionnaires to measure  
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35 HL, such as the Rapid Estimate of Adult Literacy in Medicine(18, 19), Cancer Health Literacy Test-30 (CHLT-30)(20),  
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37 the Short-Form Test of Functional Health Literacy in Adults (S-TOFHLA)(5, 21, 22), et al. which are also impractical for  
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39 use in busy clinical settings. Despite differences in the nature of HL assessment techniques, our results are consistent with  
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41 those of previous studies that identified inadequate HL as a risk factor for QOL among cancer survivors.(19, 23, 24)  
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47 Our results showing a higher adequate HL level are in contrast to those from other studies(25, 26) which found a lower  
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49 adequate HL in Chinese population. This might because the participants we surveyed were all come from the Cancer  
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51 Rehabilitation Club in Shanghai. The club(27) firmly “anti-cancer groups, beyond life”, and organizing a variety of  
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53 rehabilitation activities to make patients feel full confidence of their rehabilitation. They spread new concept of treatment  
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55 and health education mode their own health, such as “group psychotherapy”, “create a new life”, “qigong physical exercise”,  
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4 “five-full philosophy”, “participation in management”, et al. Through this process, participants in the club will have their  
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7 HL level gradually improved. This might be the reason why our results were higher than other studies.

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9 We chose QOL as the primary outcome of interest were because it can fully reflect the feeling and physical recovery  
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11 condition of the patients and has been increasingly used as a comprehensive health indicator in clinical treatment and  
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13 interventions(8, 28). QOL can be used as one of the indicators of efficacy of different therapeutic measures. The  
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15 combination of QOL and clinical curative effect observation index can help to choose the treatment that is more suitable  
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17 for patients. To evaluate the difference of QOL before and after treatment can help doctors have a whole understanding  
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19 about the patients’ true feelings and health, so that they can in different stages of different measures. Studies have  
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21 demonstrated that there is a negative relationship between QOL and HL(19, 24). Inadequate health literacy is independently  
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23 associated with poor QOL and higher rates of (29). Consistent with these researches, our study showed that cancer survivors  
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25 with adequate HL had nearly 3 times the odds of having a better QOL than cancer survivors with inadequate HL.  
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34 Form the public health perspective, HL is an important factor in ensuring significant health outcomes.(30-32) Inadequate  
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36 HL may contribute to the disproportionate burden of cancer-related problems among disadvantaged populations. The  
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38 United Nations ECOSOC Ministerial Declaration of 2009 provided a clear mandate for action “call for the development  
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40 of appropriate action plans to promote health literacy.”(2) The 9<sup>th</sup> Global Conference was held in Shanghai, China (2016)  
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42 and addressed the determinants of health through good governance, health cities, health literacy and social mobilization.(2)  
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45 Therefore, improving cancer survivors' health literacy is an important targets for improving their QOL.  
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50 Several limitations should be considered in the interpretation of our findings. First, it was a cross-sectional study and  
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52 didn't allow us to make a causal inference whether low HL was causally associated with poor QOL. Second, we didn't use  
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54 the questionnaire of Chinese residents health literacy monitoring and other complex tool to evaluate the HL, and the 3 brief  
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56 questions may reflect other constructs, but the 3 brief questions can easily be incorporated into the clinical routine work  
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4 and are useful to identify high-risk patients. Third, this study might only have a good representativeness of the cancer  
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6 survivors in Shanghai Cancer Rehabilitation Club and may not be generalizable to non-members of Cancer Rehabilitation  
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8 Club. However, as discussed above, if the effect of inadequate HL would be weakened in these participants, it may be greater  
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10 in different populations.  
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## 14 **Conclusions**

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17 In summary, inadequate health literacy as evaluated by 3 brief screening questions is independently associated with poor  
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19 QOL in cancer survivors. Efforts should focus on developing and evaluating interventions to improve QOL among cancer  
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21 survivors with inadequate HL.  
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## 25 **DECLARATIONS**

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28 **Ethics approval and consent to participate:** Informed consent was obtained from all participants before enrollment. The  
29  
30 protocol was approved by the committee of Public Health School of Fudan University (protocol number IRB # 2017-05-  
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37 **Consent for publication:** Not applicable  
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40 **Availability of data and material:** Please contact author for data requests.  
41

42  
43 **Competing interests:** The authors declare that they have no competing interests.  
44

45  
46 **Funding:** Not applicable  
47

48  
49 **Authors' contributions:** Juan Xia carried out the field investigation, participated in the design of the study, performed the  
50  
51 statistical analysis and drafted the manuscript. Qing-Long Deng, Rui Yan, Peng Wu, Ren-Ren Yang and Bing-hui Lv  
52  
53 participated in the field investigation and data collection. Ji-Wei Wang and Jin-Ming Yu designed and coordinated the  
54  
55 study and revised the manuscript. All authors read and approved the final manuscript.  
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58  
59 **Acknowledgements:** We wish to thank Furong Tang, Donghui Yu, Mengxue Yin and some other volunteers who  
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contributed to this survey. We also wish to thank the thousands of cancer survivors who were willing to complete the survey.

For peer review only

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**Figure Title:**

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Figure 1. Item Characteristic Curve and Test Information Curve for the 3 established screening questions

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Figure 2. Unadjusted QOL scores for cancer survivors with inadequate and adequate health literacy

Table 1. Characteristics of Respondent stratified by Health Literacy Level\*

Characteristics	Total (N=4589)	Level of Health Literacy		P value
		Adequate (n=4430)	Inadequate (n=159)	
Age, M (Q1,Q3), y	62.0 (57.04,66.53)	62.0 (57.00,66.53)	62.52 (58.37,68.39)	0.0485
Years with cancers, M (Q1,Q3)	6.09 (3.50,10.50)	6.09 (3.50,10.50)	5.92 (3.50,10.58)	0.6258
Sex, No.(%)				0.9424
Male	1057 (23.03)	1020 (96.50)	37 (3.50)	
Female	3532 (76.97)	3410 (96.55)	122 (3.45)	
Race				0.8644
Hanzu	4544 (99.28)	4386 (96.52)	158 (3.48)	
Marriage				0.2192
single	129 (2.81)	121 (93.80)	8 (6.20)	
married/ cohabitation	3989 (86.93)	3853 (96.61)	136 (3.41)	
divorced/widowed/ separated	471 (10.226)	456 (96.82)	15 (3.18)	
Annual income, ¥				0.0534
<5000	4134 (91.89)	3987 (96.44)	147 (3.56)	
≥5000	365 (8.11)	359 (98.36)	6 (1.64)	
Family income				0.8296
<5000	3086 (70.07)	2979 (96.53)	107 (3.47)	
≥5000	1318 (29.93)	1274 (96.66)	44 (3.34)	
Education				0.0003
Middle school or less	4021 (87.62)	3867 (96.17)	154 (3.83)	
High school or college	568 (12.38)	563 (99.12)	5 (0.88)	
Insurance status				0.8159
Uninsured	645 (15.55)	623 (96.59)	22 (3.41)	
Medicare	3504 (84.45)	3378 (96.40)	126 (3.60)	
Treatment regimen				0.2753
Chemotherapy	661 (14.44)	641 (96.97)	20 (3.03)	
Radiotherapy	74 (1.62)	68 (91.89)	6 (8.11)	
Operation	931 (20.34)	902 (96.89)	29 (3.11)	
Chemotherapy & Radiotherapy	162 (3.54)	155 (95.68)	7 (4.32)	
Chemotherapy & Radiotherapy & Operation	897 (19.59)	870 (96.99)	27 (3.01)	
Chemotherapy & Operation	1658 (36.22)	1594 (96.14)	64 (3.86)	
Biotherapy	69 (1.51)	66 (95.65)	3 (4.35)	
Number of Chronic disease				0.3564
0	1238 (26.98)	1203 (97.17)	35 (2.83)	
1-3	2735 (59.60)	2634 (96.31)	101 (3.69)	
>3	616 (13.42)	593 (96.27)	23 (3.73)	
Smoking habit				0.5284
Never	3841 (83.70)	3711 (96.62)	130 (3.38)	
Former	598 (13.03)	573 (95.82)	25 (4.18)	



Current	150 (3.27)	146 (97.33)	4 (2.67)	
Current alcohol use				0.0637
None	4264 (92.92)	4113 (96.46)	151 (3.54)	
Light to moderate	215 (4.69)	213 (99.07)	2 (0.93)	
Heavy	110 (2.40)	104 (94.55)	6 (5.45)	
Body mass index#				0.4593
<18.5	233 (5.16)	229 (98.28)	4 (1.72)	
18.5-23.9	2342 (51.85)	2258 (96.41)	84 (3.59)	
24.0-27.9	1546 (34.23)	1492 (96.51)	54 (3.49)	
≥28.0	396 (8.77)	380 (95.96)	16 (4.04)	
Excise				0.0264
No	1038 (22.64)	991 (95.47)	47 (4.53)	
1-4 times per week	2493 (54.37)	2406 (96.51)	87 (3.49)	
≥5 times per week	1054 (22.99)	1029 (97.63)	25 (2.37)	

\* Data are given as percentages unless otherwise indicated.

# Calculated as weight in kilograms divided by the square of height in meters.

Table 2. Relationship Between Survivors Characteristics and QOL

Predictor	Unadjusted		Adjusted*	
	Coefficient $\tau$	P Value	Coefficient $\tau$	P Value
HL score	-2.11	<0.0001	-2.07	<0.0001
Age	-0.25	<0.0001	-0.16	0.0053
Sex, female	-3.92	<0.0001	-5.02	0.0002
Race/ethnicity	2.10	0.5854	6.41	0.1819
Marriage	-3.01	0.0051	-2.14	0.0710
Education	-0.28	0.6316	-1.38	0.0319
Annual income	0.42	0.7664	0.81	0.6044
Family income	-0.03	0.9694	0.53	0.5521
Insurance status	-1.67	0.1263	-0.09	0.9346
Years with cancer (per year)	-0.23	0.0002	-0.04	0.5401
Number of Chronic disease	-5.79	<0.0001	-4.87	<0.0001
Smoking habit	1.35	0.015	-1.23	0.1210
Alcohol intake	3.38	<0.0001	2.07	0.0240
Excise	4.07	<0.0001	3.15	<0.0001
Treatment regimen	-0.004	0.985	0.16	0.4474
District	0.63	<0.0001	0.48	<0.0001
BMI	1.14	0.0305	2.18	<0.0001

\* Adjusted for age, sex, race, marriage, income, education, insurance, years with cancer, treatment regimen, district, number of chronic disease, smoking habit, alcohol use, excise and BMI.

$\tau$  All coefficients correspond to a change in QOL score for unit change of each covariate.

Table 3. Adjusted Odds Ratio of QOL for cancer survivors with inadequate vs adequate health literacy\*

QOL	Survivors with poor QOL	Odds Ratio (95%CI)	P value
Global health status (QL)	788	2.81 (1.94-4.06)	<0.0001
Physical function (PF)	83	2.84 (1.18-6.87)	0.0205
Role function (RF)	53	2.70 (0.94-7.80)	0.0664
Emotional function (EF)	77	5.01 (2.37-10.58)	<0.0001
Cognitive function (CF)	128	4.07 (2.18-7.61)	<0.0001
Social function (SF)	250	3.59 (2.19-5.88)	<0.0001
Fatigue (FA)	425	2.63 (1.68-4.12)	<0.0001
Nausea/Vomiting (NV)	52	5.39 (2.17-13.38)	0.0003
Pain (PA)	296	2.37 (1.41-3.97)	0.0011
Dyspnea (DY)	152	1.86 (0.88-3.94)	0.106
Insomnia (SL)	475	2.41 (1.56-3.74)	<0.0001
Appetite loss (AP)	91	3.84(1.84-8.03)	0.0003
Constipation (CO)	188	1.06 (0.45-2.46)	0.8995
Diarrhea (DI)	114	2.11 (0.95-4.71)	0.0679
Financial difficulties (FI)	747	2.73 (1.88-3.97)	<0.0001

\*Adjusted for age, sex, race, marriage, income, education, insurance, years with cancer, treatment regimen, district, number of chronic disease, smoking habit, alcohol use, excise and BMI

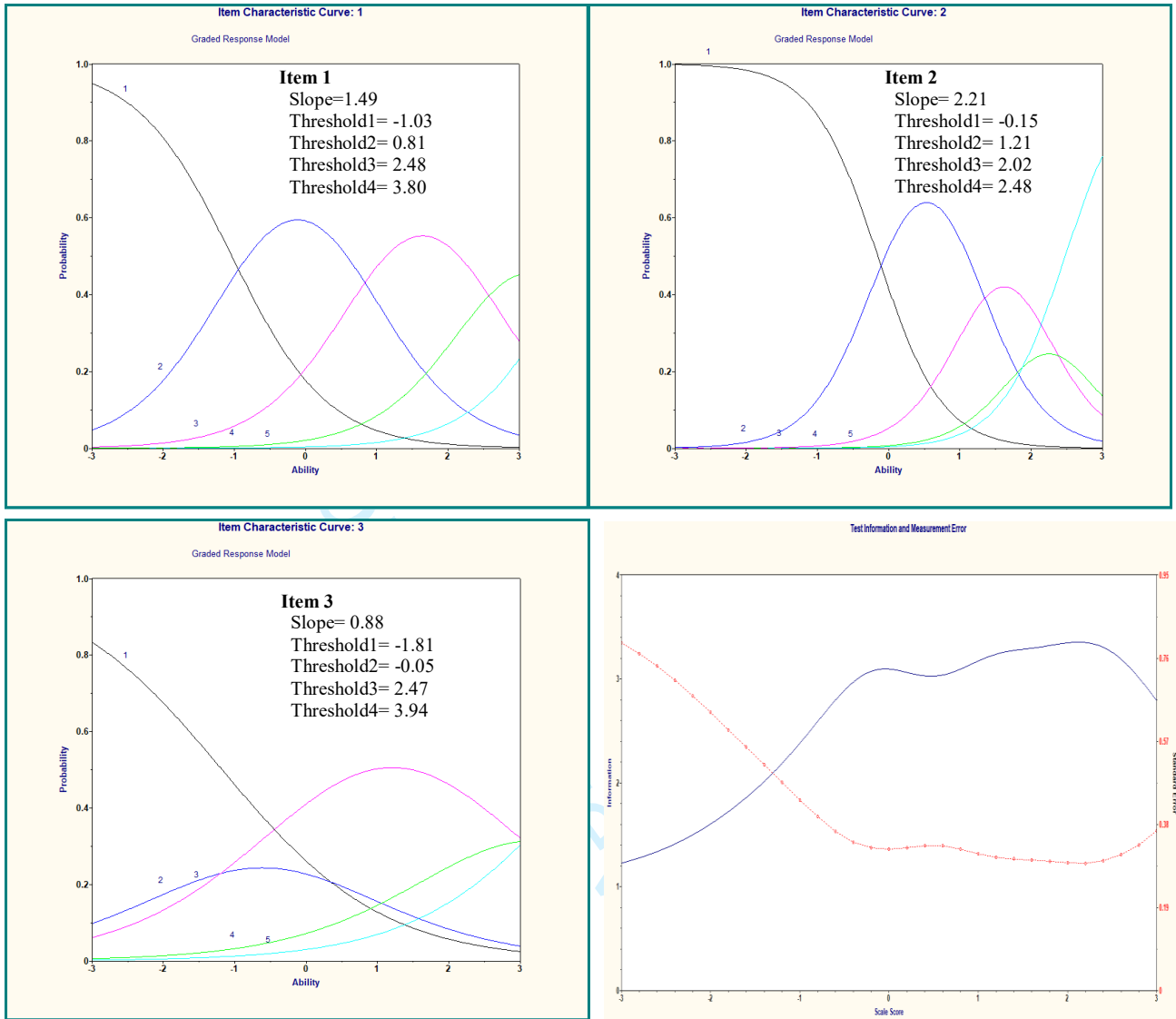


Figure 1. Item Characteristic Curve and Test Information Curve for the 3 established screening questions

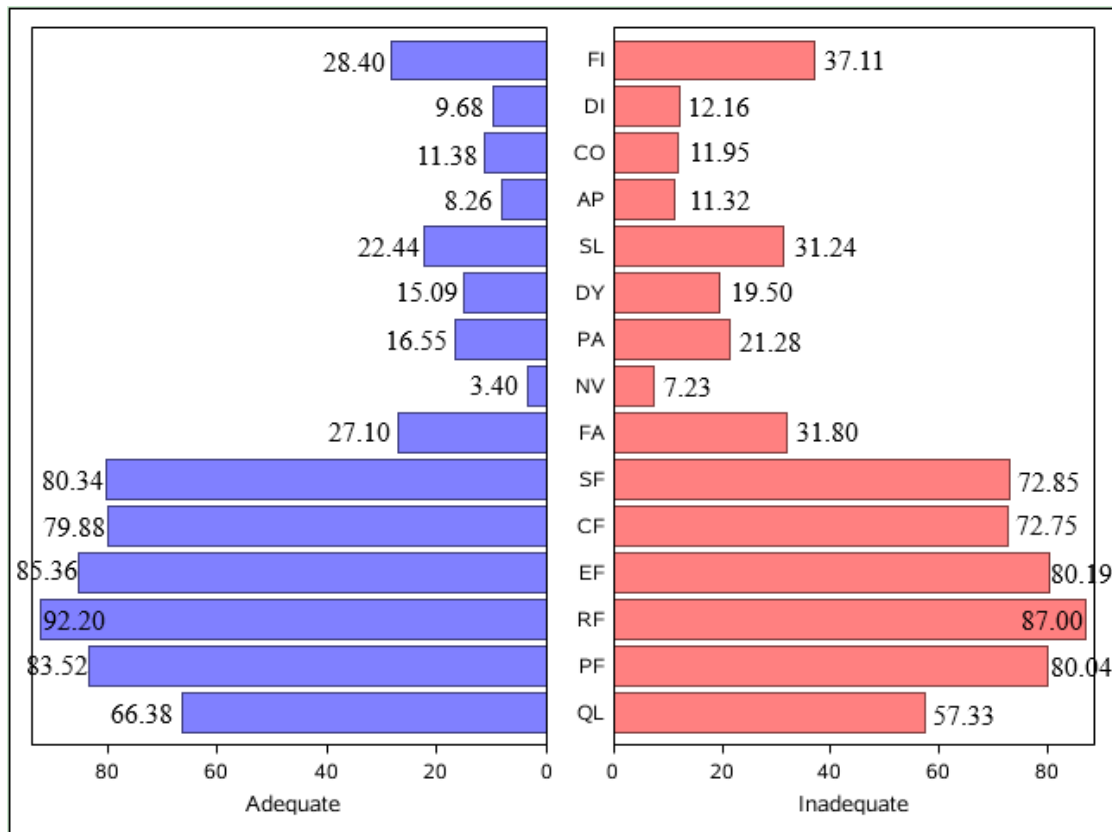


Figure 2. Unadjusted QOL scores for cancer survivors with inadequate and adequate health literacy

# BMJ Open

## Health Literacy and Quality of Life among Cancer Survivors in China

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-028458.R1
Article Type:	Original research
Date Submitted by the Author:	19-Jul-2019
Complete List of Authors:	Xia, Juan; Fudan University, school of public health Wu, Peng; Fudan University, school of public health Deng, Qinglong; Fudan University, school of public health Yan, Rui; Fudan University, school of public health Yang, Renren; Fudan University, school of public health Lv, Binghui; Fudan University, school of public health Wang, Jiwei; Fudan University, Fudan university school of public health Yu, Jinming; Fudan University, school of public health
<b>Primary Subject Heading</b>:	Public health
Secondary Subject Heading:	Oncology
Keywords:	Health Literacy, 3 Brief Questions, Quality of Life, Cancer Survivors

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Manuscripts

**Title Page**

**Title:** Health Literacy and Quality of Life among Cancer Survivors in China

**Running title:** Health Literacy and QOL in Cancer

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**Manuscript word count:** 2858 words

**Numbers of references:** 39

**Numbers of tables and figures:** 3 tables and 2 figure

**Abstract word count:** 290 words

**Key words:** Health Literacy; 3 Brief Questions; Quality of Life; Cancer Survivors

**Conflict of interest statement:** The authors declare no potential conflicts of interest.

## Health Literacy and Quality of Life among Cancer Survivors in China

**Objective** To evaluate the association between Health Literacy (HL) and Quality of Life (QOL) among Cancer Survivors in China.

**Design** Cross-sectional observational study in China.

**Setting and participants** Cross-sectional observational study of 4713 cancer survivors who were older than 18 years came from the Shanghai Cancer Rehabilitation Club. Participants were enrolled and completed questionnaires between May and July 2017.

**Measurement** HL were assessed by 3 established screening questions and QOL was evaluated using the simplified Chinese version of the quality-of-life questionnaire-core 30 items (EORTC QLQ-30). All questionnaires were collected through face-to-face interviews or self-administered by literate participants. Participants were excluded if they did not complete at least 1 HL question. Baseline characteristics were compared by levels of HL using  $\chi^2$  test for categorical variables and Wilcoxon test for the non-normal continuous variables. Item Response Theory (IRT) was used to evaluate the existing measure of health literacy. Linear regression models and Logistic regression models were used to investigate the association between HL and QOL. SAS 9.4 and MULTILOG 7.03 were applied for analysis.

**Results** Valid selection of subjects in this study were 4589. IRT scaling parameters of the health literacy measure found items had a good range of discriminating and difficulty. Of 4589 included responders, 159 (3.5%) had low HL. After adjusting for participants' sociodemographic characteristics, treatment regimen, and years with cancers, for each 1-point decrement in HL score, the QOL score increased by 2.07 ( $P<0.001$ ). Cancer survivors with low HL were less likely than those with adequate HL to achieve a better QOL. In logistic regression, low HL was independently associated with poor QOL (adjusted odds ratio, 2.81 [95% confidence interval], 1.94-4.06;  $P<0.001$ ).

**Conclusions** Among cancer survivors in Shanghai Cancer Rehabilitation Club, low HL was independently associated with poor QOL.

**Key words:** Health Literacy; 3 Brief Questions; Quality of Life; Cancer Survivors

### Article summary

- Cancer survivors with adequate Health Literacy had nearly 3 times the odds of having a better Quality of Life than cancer survivors with inadequate Health Literacy.
- Improving cancer survivors' health literacy might be an important targets for improving their QOL.

### Strengths and limitations of this study

- To the best of our knowledge, few studies using 3 brief screening questions to evaluate Chinese cancer survivors' health literacy instead of the complex and long questions which are not suitable to use in clinical routine practice, and to explore its relationship with quality of life.
- Item response theory was used to evaluate whether a summed unidimensional health literacy scale could be used.
- Causal inferences could not be allowed due to the cross-sectional design.
- The proportion of high HL might be overestimated, and low literacy patients are often excluded from the study because of illiteracy.

### Introduction

Health literacy (HL) is an evolving concept. As defined by the National Library of Medicine (1), HL is “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions.” It means more than simply the ability to “read pamphlets”, “make appointments”, “understand food labels” or “comply with prescribed actions” from a doctor (2). Higher levels of HL within populations yield social benefits (3, 4), and HL is an important factor in ensuring significant health outcomes (5, 6).

Cancer is one of the leading causes of morbidity and mortality worldwide (7) and the economic impact of cancer is increasing. Despite the fact that China had a lower incidence rate of cancer compared with western countries, it increased with a sharp slope in decades (8, 9). Meanwhile, patients nowadays are detected with advanced diagnostic techniques and cured by modern therapeutic methods, which resulted in the extension of lifespan of cancer patients and more attention paid to the quality of life in their survival years (10).

Quality of Life (QOL) has been increasingly used as a comprehensive health indicator in clinical treatment and interventions (11). Studies evaluating the relationship between HL and HRQOL produced mixed results among cancer survivors. Researches (12-14) conducted among cancer patients were reported that HL was positively related to the QOL. While Elizabeth A. Hahn et al. indicated that low literacy is not an independent risk factor for poorer HRQL among breast cancer (15). Isolating the independent contribution of HL toward cancer survivors' QOL would have important clinical and public health implications. A growing body of research measured HL with complex and long questions that are not suitable to use in clinical routine practice (16). Therefore, the purpose of this study was to evaluate the association between HL and QOL among cancer survivors in Shanghai Cancer Rehabilitation Club using 3 brief screening questions.



## METHODS

### Design and setting

A cross-sectional study was conducted from May to July 2017. All participants were recruited from Shanghai Cancer Rehabilitation Club, a nongovernmental self-help mutual aid organization that contains 20 members of the branch offices, 175 community block group, and more than 13,000 members. The present study covered 16 districts in Shanghai (Huangpu, Pudong, Xuhui, Changning, Putuo, Hongkou, Yangpu, Minhang, Baoshan, Jiading, Jinshan, Songjiang, Qingpu, Fengxian, Chongming, and Jingan).

### Participants

The subjects of our study were cancer survivors who took part in SCRC. The inclusion criteria for study enrollment were as shown below: 1) at least 18-year-old; 2) have a pathological diagnosis of cancer; 3) able to independently participate in the cancer rehabilitation club; 4) willingness to provide written informed consent; 5) no cognitive impairment or psychotic disorder. The information leaflets about the content and purpose of this study and written informed consent forms were obtained from patients who met the inclusion criteria ahead of the investigation, and a box of eggs was offered for their participation as gifts. Investigators who were all students of Fudan University were trained and field investigation was conducted. Questionnaires were collected through face-to-face interviews with the help of well-trained field workers or self-administered by literate participants. 4713 cancer survivors were surveyed, 4610 got responses. Except for the incomplete, we totally acquired 4589 valid questionnaires. The protocol was approved by the committee of the Public Health School of Fudan University (protocol number IRB # 2017-05-0621).

### Measures

HL was assessed using 3 established screening questions and categorized as adequate or inadequate (17-20). The items included: "How often do you have someone help you read hospital materials?", "How confident are you filling out forms by yourself", and "How often do you have problems learning about your medical condition because of difficulty reading hospital materials?". Each question was scored by participants on a 5-point scale. HL was evaluated as a continuous and dichotomous variable. Based on prior literature (16), scores were summed, and participants were categorized as low HL if their total score was greater than 10 and adequate HL if it was 10 or lower.

QOL was assessed using the simplified Chinese version of the quality-of-life questionnaire-core 30 items (EORTC QLQ-30), which incorporates nine multi-item scales (21): five functional scales (physical, role, cognitive, emotional, and social functioning), three symptom scales (fatigue, pain, and nausea/vomiting), and a global health status/QOL scale; and six

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4 single-item scales (dyspnea, insomnia, appetite loss, constipation, diarrhea, and financial difficulties). The psychometric  
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6 properties of the questionnaire had been previously evaluated (22). Scale scores were calculated by averaging items within  
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8 scales and transforming average scores linearly. All of the scales range in scores from 0 to 100. A high score for a functional  
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10 scale represents a high/healthy level of functioning whereas a high score for a symptom scale or item represents a high  
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12 level of symptomatology or problems. For more details on the scoring procedures see the EORTC QLQ-C30 Scoring  
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14 Manual (23). Participants were classified as having better QOL if their scores were higher than 50 and poor QOL if it was  
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16 lower than 50.

### 17 **Other variables**

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20 Covariates were age, sex, race/ethnicity, socioeconomic status, education level, marital status (married vs single or  
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22 divorced/widowed), insurance status, years with cancer, smoking habit, alcohol use, physical activity, treatment regimen,  
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24 district, BMI and history of coexisting illnesses. Because coexisting illnesses may affect survivors QOL, we measured  
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26 coexisting illnesses conditions by asking cancer survivors whether they had ever been told by a physician that they had  
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28 chronic diseases, including hypertension, hyperlipemia, hyperuricemia, diabetes, heart disease, stroke, respiratory disease,  
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30 digestive system disease, and skeleton system diseases. All covariates were determined at the time of the survey.

### 31 **Statistical Analysis**

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34 To determine whether a summed unidimensional health literacy scale could be used, item response theory (IRT) was  
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36 used to evaluate the item parameter (discrimination parameter, threshold parameter), item characteristic curve (ICC) and  
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38 item information curve (IIF). For the items were ordered responses, the Graded Response Model (GRM) was used. For the  
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40 participants answering only 1 or 2 of the 3 questions, the score for those questions was multiplied by 3 and 1.5, respectively  
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42 (16).

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44 Baseline characteristics were compared across levels of HL using  $\chi^2$  test for categorical variables and the Wilcoxon  
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46 test for the non-normal continuous variables. Linear regression models were used to estimate the association between HL  
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48 score and QOL after controlling for differences in participants' characteristics, including age, sex, race/ethnicity, marriage,  
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50 education, income, insurance status, years with cancer, number of chronic disease, smoking habit, alcohol use, physical  
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52 activity, treatment regimen, district and BMI. Logistic regression models were used to measure the independent relationship  
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54 between HL and each of the QOL scale, while adjusting for other potentially confounding survivor characteristics.

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56 The IRT analyses were conducted using the MULTILOG version 7.03. Other statistical analyses were performed with  
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58 SAS version 9.4 for each analysis, the null hypothesis was evaluated at a 2-sided significance level of 0.05.

## Patient and public involvement

Patients and public were not involved in the development of the research question or in the design of the study.

## Results

Among 4713 cancer survivors surveyed, 4610 responded, for a 97.81% response rate. For 4589 of the 4610 participants, at least 1 HL question was available in the survey; these participants composed our study sample.

The summed HL scale was measured by using all 3 HL questions. The correlations of single items to the total were 0.73, 0.70, and 0.75 for questions 1 to 3, respectively. Figure 1 shows the IRT models and test information for the total sample and illustrates the implications of the item parameters for the response probabilities for different levels of health literacy. All items had high discrimination parameters, except for Item 3, 'How often do you have problems learning about your medical condition because of difficulty reading hospital materials', which had moderate discrimination ( $a=0.88$ ) but still satisfy the condition of  $a>0.75$ . The difficulty parameters (Threshold) increased monotonically across rating scale categories for all items, ranging from -1.81 to 3.94, indicating that the 3 HL questions discriminate well. Among the 4589 participants in the study, the mean HL score was 6.3 (range, 3-15). As table 1 shows, one hundred fifty-nine participants (3.5%) had low HL (HL score, 11-15). Participants with low HL were more likely than participants with adequate HL to be older, to have received only some middle school education or less, and to have had a little exercise.

Table 2 presents the bivariate relationships between predictors of QOL and cancer survivors' global health status. The HL score, age, sex, marriage, years with cancer, number of chronic diseases, smoking habit, alcohol use, physical activity, district, and BMI were all associated with QL. After adjustment for other potentially confounding factors, marriage, years with cancer, and smoking habit were no significant differences. For each 1-point decrement in the HL score, the QL value increased by 2.07 ( $P<.001$ ).

Cancer survivors with adequate HL were more likely than cancer survivors with low HL to have a high score for a functional scale whereas a low level of symptomatology. According to the recommendation(24), a difference on the 0–100 scale of more than 5 points were considered as a clinically important difference. As can be seen from the data in Figure 2 that there had a clinically significant difference between survivors with adequate HL and survivors with low HL, in terms of global health status (difference of adequate HL vs low HL [diff], 9.05), role function (diff: 5.2), emotional function (diff: 5.17), cognitive function (diff: 7.13), social function (diff: 7.49), insomnia (diff: -8.8), and financial difficulties (diff: -8.71).

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4 Eighty-three percent of cancer survivors with adequate HL and 65% of cancer survivors with low HL reported that they  
5 had a good global health status (unadjusted odds ratio [OR], 2.75; 95% confidence interval [CI], 1.97-3.84;  $P < .001$ ). After  
6 confounders were adjusted, cancer survivors with adequate HL were more likely to report a better global health status  
7 (adjusted OR, 2.81; 95% CI, 1.94-4.06;  $P < .001$ ) (Table 3). The extent of the associations between HL and other scales of  
8 QOL, including four functional scales (physical, emotional, cognitive and social functioning), three symptom scales  
9 (fatigue, pain, and nausea/vomiting), and three single-item (insomnia, appetite loss, and financial difficulties), was similar  
10 to that of global health status and all had a statistical significance (Table 3).  
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## 18 Discussion

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20 Our study demonstrates that inadequate HL as assessed by 3 brief screening questions was present in less than 1 in 25  
21 cancer survivors in Shanghai Cancer Rehabilitation Club. And inadequate HL was an independent predictor of poor QOL  
22 and was associated with a lower level of functioning and a higher level of symptomatology or problems. The association  
23 between HL and QOL that we observed is significant from a clinical and public health perspective. These findings highlight  
24 a potential target for interventions to improve the overall quality of life for cancer survivors.  
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30 To our knowledge, few studies had demonstrated the association between HL and QOL among cancer survivors using  
31 the 3 brief screening questions. Prior research studies have used more complex and extensive questionnaires to measure  
32 HL, such as the Rapid Estimate of Adult Literacy in Medicine (25, 26), Cancer Health Literacy Test-30 (CHLT-30) (27),  
33 the Short-Form Test of Functional Health Literacy in Adults (S-TOFHLA) (5, 28, 29), et al. which are also impractical for  
34 use in busy clinical settings. Despite differences in the nature of HL assessment techniques, our results are consistent with  
35 those of previous studies that identified inadequate HL as a risk factor for QOL among cancer survivors. (26, 14, 12) Our  
36 results showing a higher adequate HL level are in contrast to those from other studies(30, 31) which found a lower adequate  
37 HL in the Chinese population. This might because the participants we surveyed were all come from the Cancer  
38 Rehabilitation Club in Shanghai. The club (32) firmly “anti-cancer groups, beyond life”, and organizing a variety of  
39 rehabilitation activities to make patients feel full confidence in their rehabilitation. They spread new concept of treatment  
40 and health education mode their own health, such as “group psychotherapy”, “create a new life”, “qigong physical exercise”,  
41 “five-full philosophy”, “participation in management”, et al. Through this process, participants in the club will have their  
42 HL level gradually improved. This might be the reason why our results were higher than in other studies.  
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56 We chose QOL as the primary outcome of interest were because it can fully reflect the feeling and physical recovery  
57 condition of the patients and has been increasingly used as a comprehensive health indicator in clinical treatment and  
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4 interventions (11, 33). QOL can be used as one of the indicators of efficacy of different therapeutic measures. The  
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6 combination of QOL and clinical curative effect observation index can help to choose the treatment that is more suitable  
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8 for patients. To evaluate the difference of QOL before and after treatment can help doctors have a whole understanding of  
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10 the patients' true feelings and health so that they can in different stages of different measures. Studies have demonstrated  
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12 that there is a negative relationship between QOL and HL(26, 12), and inadequate health literacy is independently  
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14 associated with poor QOL (34). Consistent with this researches, our study showed that cancer survivors with adequate HL  
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16 had nearly 3 times the odds of having a better QOL than cancer survivors with inadequate HL.

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18 From the public health perspective, HL is an important factor in ensuring significant health outcomes. (12, 35, 36)  
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20 Inadequate HL may contribute to the disproportionate burden of cancer-related problems among disadvantaged populations.  
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22 The United Nations ECOSOC Ministerial Declaration of 2009 provided a clear mandate for action "call for the  
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24 development of appropriate action plans to promote health literacy." (2) The 9<sup>th</sup> Global Conference was held in Shanghai,  
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26 China (2016) and addressed the determinants of health through good governance, health cities, health literacy, and social  
27  
28 mobilization.(2) Therefore, improving cancer survivors' health literacy is an important target for improving their QOL.

29  
30 Besides that, participants with low HL were more likely than those with adequate HL to have received only some middle  
31  
32 school education or less and to have had a little exercise. Meanwhile, the education background and behaviors (alcohol use  
33  
34 and physical activity) were all associated with QL. Information needs and understand of the person living with a chronic  
35  
36 condition is critical for the optimal management (13). People with higher education levels have a better chance to acquire  
37  
38 health information about this kind of disease as well as understand doctors' advice, and adopt a healthy lifestyle, such as  
39  
40 drink less alcohol and exercise regularly. The previous study reported that physical activity contributes to not only physical  
41  
42 health but to the emotional, social, cognitive and even the spiritual domain (37). This fit particularly with self-determination  
43  
44 theory that is when participants find physical activity could meet needs and contribute to QOL, move up the continuum  
45  
46 toward more self-determined motivation. That positive cycle, with PA enhancing QOL, and enhanced QOL motivating  
47  
48 participation creates a positive health cycle (38). Meanwhile, recent cohorts study conducted in Hong Kong reported that  
49  
50 alcohol reduction to be associated with better mental well-being (39), which may have a positive effect on QOL.

### 51 52 **Limitation**

53  
54 Several limitations should be considered in the interpretation of our findings. First, it was a cross-sectional study and  
55  
56 didn't allow us to make a causal inference whether low HL was causally associated with poor QOL, and interventions  
57  
58 should be conducted in the further research. Second, we didn't use the questionnaire of Chinese residents health literacy  
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4 monitoring and other complex tool to evaluate the HL, and the 3 brief questions may reflect other constructs, but the 3 brief  
5  
6 questions can easily be incorporated into the clinical routine work and are useful to identify high-risk patients. Third, this  
7  
8 study might only have a good representativeness of the cancer survivors in Shanghai Cancer Rehabilitation Club and may  
9  
10 not be generalizable to non-members of Cancer Rehabilitation Club. However, as discussed above, if the effect of  
11  
12 inadequate HL would be weakened in these participants, it may be greater in different populations.

### 13 14 **Conclusions**

15  
16 In summary, inadequate health literacy as evaluated by 3 brief screening questions is independently associated with poor  
17  
18 QOL in cancer survivors. Efforts should focus on developing and evaluating interventions to improve QOL among cancer  
19  
20 survivors with inadequate HL.

### 21 22 **DECLARATIONS**

23  
24 **Ethics approval and consent to participate:** Informed consent was obtained from all participants before enrollment. The  
25  
26 protocol was approved by the committee of Public Health School of Fudan University (protocol number IRB # 2017-05-  
27  
28 0621).

29  
30 **Consent for publication:** Not applicable

31  
32 **Availability of data and material:** Please contact author for data requests.

33  
34 **Competing interests:** The authors declare that they have no competing interests.

35  
36 **Funding:** Not applicable

37  
38 **Authors' contributions:** Juan Xia carried out the field investigation, participated in the design of the study, performed the  
39  
40 statistical analysis and drafted the manuscript. Peng Wu in charge of the process of submission and revision of this paper.  
41  
42 Peng Wu, Qing-Long Deng, Rui Yan, Ren-Ren Yang and Bing-hui Lv participated in the field investigation and data  
43  
44 collection. Ji-Wei Wang and Jin-Ming Yu designed and coordinated the study and revised the manuscript. All authors read  
45  
46 and approved the final manuscript.

47  
48 **Acknowledgements:** We wish to thank Furong Tang, Donghui Yu, Mengxue Yin and some other volunteers who  
49  
50 contributed to this survey. We also wish to thank the thousands of cancer survivors who were willing to complete the  
51  
52 survey.  
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**Figure Title:**

Figure 1. Item Characteristic Curve and Test Information Curve for the 3 established screening questions

Figure 2. Unadjusted QOL scores for cancer survivors with inadequate and adequate health literacy

For peer review only

Table 1. Characteristics of Respondent stratified by Health Literacy Level\*

Characteristics	Total (N=4589)	Level of Health Literacy		P value
		Adequate (n=4430)	Inadequate (n=159)	
Age, M (Q1,Q3), y	62.0 (57.04,66.53)	62.0 (57.00,66.53)	62.52 (58.37,68.39)	0.0485
Years with cancers, M (Q1,Q3)	6.09 (3.50,10.50)	6.09 (3.50,10.50)	5.92 (3.50,10.58)	0.6258
Sex, No.(%)				0.9424
Male	1057 (23.03)	1020 (96.50)	37 (3.50)	
Female	3532 (76.97)	3410 (96.55)	122 (3.45)	
Race				0.8644
Hanzu	4544 (99.28)	4386 (96.52)	158 (3.48)	
Marriage				0.2192
single	129 (2.81)	121 (93.80)	8 (6.20)	
married/ cohabitation	3989 (86.93)	3853 (96.61)	136 (3.41)	
divorced/widowed/ separated	471 (10.226)	456 (96.82)	15 (3.18)	
Annual income, ¥				0.0534
<5000	4134 (91.89)	3987 (96.44)	147 (3.56)	
≥5000	365 (8.11)	359 (98.36)	6 (1.64)	
Family income				0.8296
<5000	3086 (70.07)	2979 (96.53)	107 (3.47)	
≥5000	1318 (29.93)	1274 (96.66)	44 (3.34)	
Education				0.0003
Middle school or less	4021 (87.62)	3867 (96.17)	154 (3.83)	
High school or college	568 (12.38)	563 (99.12)	5 (0.88)	
Insurance status				0.8159
Uninsured	645 (15.55)	623 (96.59)	22 (3.41)	
Medicare	3504 (84.45)	3378 (96.40)	126 (3.60)	
Treatment regimen				0.2753
Chemotherapy	661 (14.44)	641 (96.97)	20 (3.03)	

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4	Radiotherapy	74 (1.62)	68 (91.89)	6 (8.11)
5				
6	Operation	931 (20.34)	902 (96.89)	29 (3.11)
7				
8	Chemotherapy & Radiotherapy	162 (3.54)	155 (95.68)	7 (4.32)
9				
10	Chemotherapy & Radiotherapy	897 (19.59)	870 (96.99)	27 (3.01)
11				
12	& Operation			
13				
14	Chemotherapy & Operation	1658 (36.22)	1594 (96.14)	64 (3.86)
15				
16	Biotherapy	69 (1.51)	66 (95.65)	3 (4.35)
17				
18	Number of Chronic disease			0.3564
19				
20	0	1238 (26.98)	1203 (97.17)	35 (2.83)
21				
22	1-3	2735 (59.60)	2634 (96.31)	101 (3.69)
23				
24	>3	616 (13.42)	593 (96.27)	23 (3.73)
25				
26	Smoking habit			0.5284
27				
28	Never	3841 (83.70)	3711 (96.62)	130 (3.38)
29				
30	Former	598 (13.03)	573 (95.82)	25 (4.18)
31				
32	Current	150 (3.27)	146 (97.33)	4 (2.67)
33				
34	Current alcohol use			0.0637
35				
36	None	4264 (92.92)	4113 (96.46)	151 (3.54)
37				
38	Light to moderate	215 (4.69)	213 (99.07)	2 (0.93)
39				
40	Heavy	110 (2.40)	104 (94.55)	6 (5.45)
41				
42	Body mass index#			0.4593
43				
44	<18.5	233 (5.16)	229 (98.28)	4 (1.72)
45				
46	18.5-23.9	2342 (51.85)	2258 (96.41)	84 (3.59)
47				
48	24.0-27.9	1546 (34.23)	1492 (96.51)	54 (3.49)
49				
50	≥28.0	396 (8.77)	380 (95.96)	16 (4.04)
51				
52	Physical activity			0.0264
53				
54	No	1038 (22.64)	991 (95.47)	47 (4.53)
55				
56	1-4 times per week	2493 (54.37)	2406 (96.51)	87 (3.49)
57				
58	≥5 times per week	1054 (22.99)	1029 (97.63)	25 (2.37)
59				
60				

\* Data are given as percentages unless otherwise indicated.

# Calculated as weight in kilograms divided by the square of height in meters.

Table 2. Relationship Between Survivors Characteristics and QOL

Predictor	Unadjusted		Adjusted*	
	Coefficient $\tau$	P Value	Coefficient $\tau$	P Value
HL score	-2.11	<0.0001	-2.07	<0.0001
Age	-0.25	<0.0001	-0.16	0.0053
Sex, female	-3.92	<0.0001	-5.02	0.0002
Race/ethnicity	2.10	0.5854	6.41	0.1819
Marriage	-3.01	0.0051	-2.14	0.0710
Education	-0.28	0.6316	-1.38	0.0319
Annual income	0.42	0.7664	0.81	0.6044
Family income	-0.03	0.9694	0.53	0.5521
Insurance status	-1.67	0.1263	-0.09	0.9346
Years with cancer (per year)	-0.23	0.0002	-0.04	0.5401
Number of Chronic disease	-5.79	<0.0001	-4.87	<0.0001
Smoking habit	1.35	0.015	-1.23	0.1210
Alcohol intake	3.38	<0.0001	2.07	0.0240
Physical activity	4.07	<0.0001	3.15	<0.0001
Treatment regimen	-0.004	0.985	0.16	0.4474
District	0.63	<0.0001	0.48	<0.0001
BMI	1.14	0.0305	2.18	<0.0001

\* Adjusted for age, sex, race, marriage, income, education, insurance, years with cancer, treatment regimen, district, number of chronic disease, smoking habit, alcohol use, physical activity and BMI.

$\tau$  All coefficients correspond to a change in QOL score for unit change of each covariate.

Table 3. Adjusted Odds Ratio of QOL for cancer survivors with inadequate vs adequate health literacy\*

QOL	Survivors with poor QOL	Odds Ratio (95%CI)	P value
Global health status (QL)	788	2.81 (1.94-4.06)	<0.0001
Physical function (PF)	83	2.84 (1.18-6.87)	0.0205
Role function (RF)	53	2.70 (0.94-7.80)	0.0664
Emotional function (EF)	77	5.01 (2.37-10.58)	<0.0001
Cognitive function (CF)	128	4.07 (2.18-7.61)	<0.0001
Social function (SF)	250	3.59 (2.19-5.88)	<0.0001
Fatigue (FA)	425	2.63 (1.68-4.12)	<0.0001
Nausea/Vomiting (NV)	52	5.39 (2.17-13.38)	0.0003
Pain (PA)	296	2.37 (1.41-3.97)	0.0011
Dyspnea (DY)	152	1.86 (0.88-3.94)	0.106
Insomnia (SL)	475	2.41 (1.56-3.74)	<0.0001
Appetite loss (AP)	91	3.84(1.84-8.03)	0.0003
Constipation (CO)	188	1.06 (0.45-2.46)	0.8995
Diarrhea (DI)	114	2.11 (0.95-4.71)	0.0679
Financial difficulties (FI)	747	2.73 (1.88-3.97)	<0.0001

\*Adjusted for age, sex, race, marriage, income, education, insurance, years with cancer, treatment regimen, district, number of chronic disease, smoking habit, alcohol use, physical activity and BMI

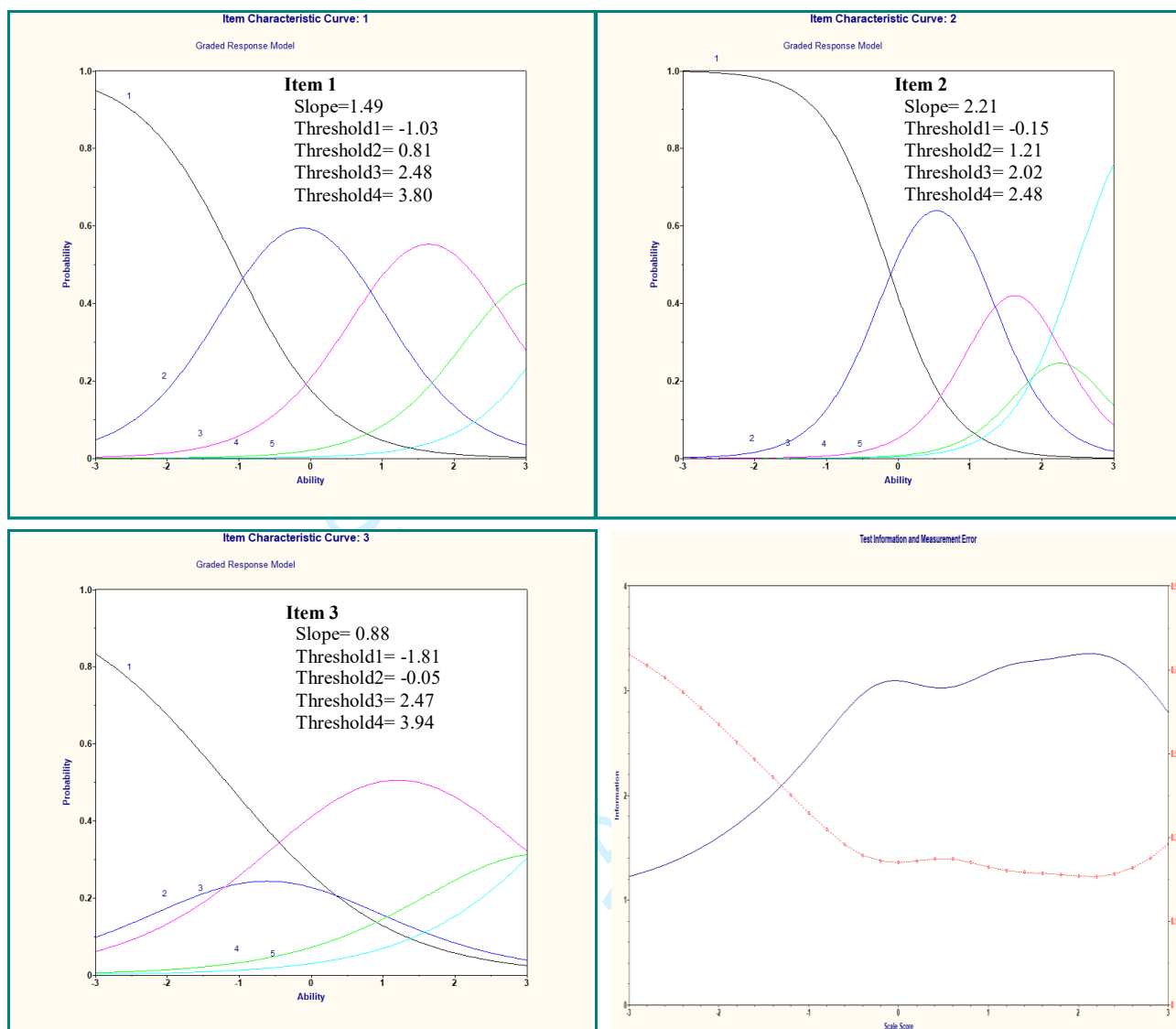


Figure 1. Item Characteristic Curve and Test Information Curve for the 3 established screening questions

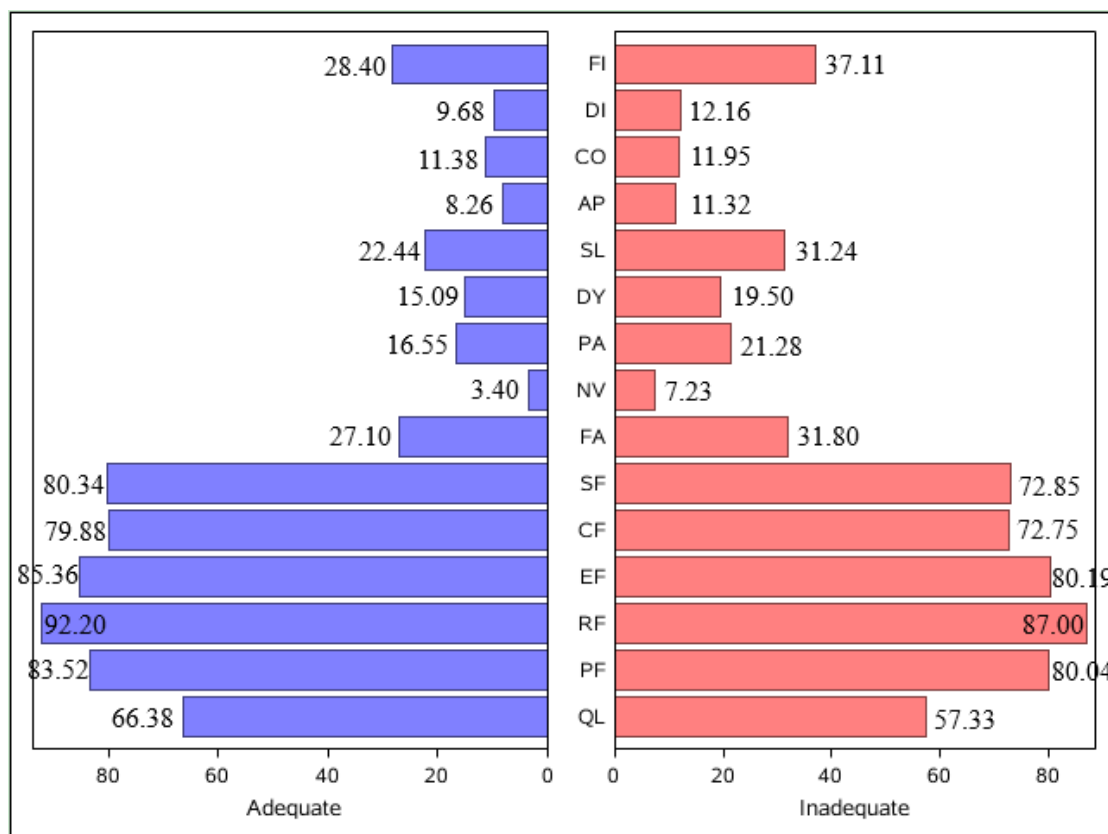


Figure 2. Unadjusted QOL scores for cancer survivors with inadequate and adequate health literacy



STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract
(Page 2, Line 6)		
(Page 2, Line 25)		(b) Provide in the abstract an informative and balanced summary of what was done and what was found
<b>Introduction</b>		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives (Page 3, Line 27-28)	3	State specific objectives, including any prespecified hypotheses
<b>Methods</b>		
Study design (Page 4, Line 3)	4	Present key elements of study design early in the paper
Setting (Page 4, Line 3-7)	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants (Page 4, Line 8-18)	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants
Variables (Page 4, Line 18-Page 5, Line 14)	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement (Page 4, Line 18-Page 5, Line 7)	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias (Page 8, Line 24)	9	Describe any efforts to address potential sources of bias
Study size (Page 4, Line 16-18)	10	Explain how the study size was arrived at
Quantitative variables (Page 5, Line 21-22)	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods (Page 5, Line 16-29)	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses
<b>Results</b>		
Participants (Page 6, Line 5-6)	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram
Descriptive data (Page 6, Line 7-16)	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest
Outcome data	15*	Report numbers of outcome events or summary measures
Main results (Page 6, Line 17- Page 7, Line 6)	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear

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which confounders were adjusted for and why they were included

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(b) Report category boundaries when continuous variables were categorized

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(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period

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Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
<b>Discussion</b>		
Key results (Page 7, Line 8-12)	18	Summarise key results with reference to study objectives
Limitations (Page 8, Line 24-Page 9, l, Line 4)	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation (Page 7, Line 13-Page 8, Line 24)	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability (Page 9, Line 5)	21	Discuss the generalisability (external validity) of the study results
<b>Other information</b>		
Funding (Page 9, Line 16)	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

\*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## Relationship between health literacy and quality of life among cancer survivors in China: a cross-sectional study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-028458.R2
Article Type:	Original research
Date Submitted by the Author:	18-Sep-2019
Complete List of Authors:	Xia, Juan; Fudan University, school of public health Wu, Peng; Fudan University, school of public health Deng, Qinglong; Fudan University, school of public health Yan, Rui; Fudan University, school of public health Yang, Renren; Fudan University, school of public health Lv, Binghui; Fudan University, school of public health Wang, Jiwei; Fudan University, Fudan university school of public health Yu, Jinming; Fudan University, school of public health
<b>Primary Subject Heading</b>:	Public health
Secondary Subject Heading:	Oncology
Keywords:	Health Literacy, 3 Brief Questions, Quality of Life, Cancer Survivors

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**Title Page**

**Title:** Relationship between health literacy and quality of life among cancer survivors in China: a cross-sectional study

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**Manuscript word count:** 4805 words

**Numbers of references:** 45

**Numbers of tables and figures:** 3 tables and 2 figure

**Abstract word count:** 292 words

**Key words:** Health Literacy; 3 Brief Questions; Quality of Life; Cancer Survivors

**Conflict of interest statement:** None declared

## Relationship between health literacy and quality of life among cancer survivors in China: a cross-sectional study

**Objective** To evaluate the association between Health Literacy (HL) and Quality of Life (QOL) among Cancer Survivors in China.

**Design** Cross-sectional study in China.

**Setting and participants** Cross-sectional observational study of 4589 cancer survivors who were older than 18 years came from the Shanghai Cancer Rehabilitation Club. Participants were enrolled and completed questionnaires between May and July 2017.

**Measurement** HL were assessed by 3 established screening questions and QOL was evaluated using the simplified Chinese version of the quality-of-life questionnaire-core 30 items (EORTC QLQ-30). All questionnaires were collected through face-to-face interviews or self-administered by literate participants. Participants were excluded if they did not complete at least 1 HL question. Baseline characteristics were compared by levels of HL using  $\chi^2$  test for categorical variables and Wilcoxon rank sum test for the non-normal continuous variables. Item Response Theory (IRT) was used to evaluate the existing measure of health literacy. Linear regression models and Logistic regression models were used to investigate the association between HL and QOL. SAS 9.4 and MULTILOG 7.03 were applied for analysis.

**Results** Valid selection of subjects in this study were 4589. IRT scaling parameters of the health literacy measure found items had a good range of discriminating and difficulty. Of 4589 included responders, 159 (3.5%) had low HL. After adjusting for participants' sociodemographic characteristics, treatment regimen, and years with cancers, for each 1-point decrement in HL score, the QOL score increased by 2.07 ( $P<0.001$ ). Cancer survivors with low HL were less likely than those with adequate HL to achieve a better QOL. In logistic regression, low HL was independently associated with poor QOL (adjusted odds ratio, 2.81 [95% confidence interval], 1.94-4.06;  $P<0.001$ ).

**Conclusions** Among cancer survivors in Shanghai Cancer Rehabilitation Club, low HL was independently associated with poor QOL.

**Key words:** Health Literacy; 3 Brief Questions; Quality of Life; Cancer Survivors

### Strengths and limitations of this study

- Few studies using 3 brief screening questions to evaluate Chinese cancer survivors' health literacy instead of

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4 the complex and long questions which are not suitable to use in clinical routine practice, and to explore its  
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6 relationship with quality of life.

- 7  
8 ● Item response theory was used to evaluate whether a summed unidimensional health literacy scale could be  
9  
10 used.
- 11  
12 ● Causal inferences could not be drawn due to the cross-sectional design employed.
- 13  
14 ● The proportion of high HL might be overestimated, and low literacy patients are often excluded from the study  
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16 because of illiteracy.

### 17 18 19 **Introduction**

20  
21 Health literacy (HL) is an evolving concept. As defined by the National Library of Medicine (1), HL is “the degree  
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23 to which individuals have the capacity to obtain, process, and understand basic health information and services  
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25 needed to make appropriate health decisions.” It means more than simply the ability to “read pamphlets”, “make  
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27 appointments”, “understand food labels” or “comply with prescribed actions” from a doctor (2). Higher levels of HL  
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29 within populations yield social benefits (3, 4), and HL is an important factor in ensuring significant health outcomes  
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31 (5, 6). Previous studies indicating that poor or limited HL can make it difficult for patients to function effectively in  
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33 the health care system, and is associated with several negative outcomes such as poor health status, decreased  
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35 comprehension of medical information, lack of engagement with doctors, higher cost of health care, and so forth (7,  
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37 8).

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40 Cancer is one of the leading causes of morbidity and mortality worldwide (9) and the economic impact of cancer  
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42 is increasing. Despite the fact that China had a lower incidence rate of cancer compared with western counties, it  
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44 increased with a sharp slope in decades (10, 11). Meanwhile, patients nowadays are detected with advanced  
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46 diagnostic techniques and cured by modern therapeutic methods, which resulted in the extension of lifespan of cancer  
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48 patients and more attention paid to the quality of life in their survival years (12).

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50 Health-related quality of life (HRQOL) refers to individuals' subjective assessment of well-being and ability to  
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52 perform social roles, has been accepted as a health indicator in medical surroundings, like clinical intervention,  
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54 treatment, and health survey (13). Studies evaluating the relationship between HL and HRQOL produced mixed  
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56 results among cancer survivors. A longitudinal, population-based study conducted in Netherlands between 2000 and  
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58 2009 (n=1643, response rate 83%) showed that low subjective HL was associated with worse QOL among colorectal  
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60 cancer survivors who registered by the Eindhoven Cancer Registry (14). A study by Elizabeth A . Hahn et al.

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4 conducted among 420 cancer outpatients enrolled at five Chicago-area cancer centers indicated that low literacy is  
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6 not an independent risk factor for poorer HRQL among cancer outpatients (15). There were other various studies on  
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8 different types of population reported different results and few similar study are conducted in less developed country,  
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10 like China.

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12 A growing body of research measured HL with complex and long questions that are not suitable to use in clinical  
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14 routine practice (16). Thus the study adopted Chew's three brief health literacy screening (BHLS) with established  
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16 validity for evaluating subjective functional HL (17). The scale only has three questions which can be easy and handy  
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18 implemented in busy clinical settings. QOL were chose as the primary outcome of interest because it can fully reflect  
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20 the feeling and physical recovery condition of the patients and has been increasingly used as a comprehensive health  
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22 indicator in clinical treatment and interventions (18, 19). QOL can be used as one of the indicators of efficacy of  
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24 different therapeutic measures. The combination of QOL and clinical curative effect observation index can help to  
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26 choose the treatment that is more suitable for patients. To evaluate the difference of QOL before and after treatment  
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28 can help doctors have a whole understanding of the patients' true feelings and health so that they can in different  
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30 stages of different measures. The simplified Chinese version of the quality-of-life questionnaire-core 30 items  
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32 (EORTC QLQ-30) was widely used to assess quality of life among cancer patients, and well-documented validity  
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34 and reliability in various populations (20, 21).

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36 Therefore, by using a population-based survey, this study aims to evaluate the association between HL and QOL  
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38 among sample of cancer survivors (breast, colorectal, lung, stomach, thyroid, and so on) in Shanghai Cancer  
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40 Rehabilitation Club using 3 brief screening questions. We hypothesize that higher HL levels would be associated  
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42 with better physical and mental well-being. Isolating the independent contribution of HL toward cancer survivors'  
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44 QOL would have important clinical and public health implications, and it help relieve the conflict between the  
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46 complexity of cancer care and health deficits, and ultimately improve patients' HRQOL (22).

## 50 METHODS

### 51 Design and setting

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53 A cross-sectional study was conducted from May to July 2017. All participants were recruited from Shanghai Cancer  
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55 Rehabilitation Club, a nongovernmental self-help mutual aid organization that contains 20 members of the branch  
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57 offices, 175 community block group, and more than 13,000 members. The present study covered 16 districts in  
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4 Shanghai (Huangpu, Pudong, Xuhui, Changning, Putuo, Hongkou, Yangpu, Minhang, Baoshan, Jiading, Jinshan,  
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6 Songjiang, Qingpu, Fengxian, Chongming, and Jingan).

### 7 8 **Participants**

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10 All subjects of our study were cancer survivors who took part in SCRC. The inclusion criteria for study enrollment  
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12 were as shown below: 1) at least 18-year-old; 2) have a pathological diagnosis of cancer; 3) able to independently  
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14 participate in the cancer rehabilitation club; 4) willingness to provide written informed consent; 5) no cognitive  
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16 impairment or psychotic disorder. The information leaflets about the content and purpose of this study and written  
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18 informed consent forms were obtained from patients who met the inclusion criteria ahead of the investigation, and a  
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20 box of eggs was offered for their participation as gifts. Investigators who were all students of Fudan University were  
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22 trained and field investigation was conducted. Questionnaires were collected through face-to-face interviews with  
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24 the help of well-trained field workers or self-administered by literate participants. 4713 cancer survivors were  
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26 surveyed, 4610 got responses. Except for the incomplete (All three questions are not answered as incomplete), we  
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28 totally acquired 4589 valid questionnaires. The protocol was approved by the committee of the Public Health School  
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30 of Fudan University (protocol number IRB # 2017-05-0621).

### 31 32 **Measures**

33  
34 HL was assessed using 3 established screening questions and categorized as adequate or inadequate (23-26). The  
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36 items included: “How often do you have someone help you read hospital materials?”, “How confident are you filling  
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38 out forms by yourself”, and “How often do you have problems learning about your medical condition because of  
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40 difficulty reading hospital materials?”. Each question was scored by participants on a 5-point scale. HL was evaluated  
41  
42 as a continuous and dichotomous variable. Based on prior literature (16), scores were summed, and participants were  
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44 categorized as low HL if their total score was greater than 10 and adequate HL if it was 10 or lower.

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46 QOL was assessed using the simplified Chinese version of the quality-of-life questionnaire-core 30 items (EORTC  
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48 QLQ-30), which incorporates nine multi-item scales (27): five functional scales (physical, role, cognitive, emotional,  
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50 and social functioning), three symptom scales (fatigue, pain, and nausea/vomiting), and a global health status/QOL  
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52 scale; and six single-item scales (dyspnea, insomnia, appetite loss, constipation, diarrhea, and financial difficulties).  
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54 The psychometric properties of the questionnaire had been previously evaluated (28). Scale scores were calculated  
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56 by averaging items within scales and transforming average scores linearly. All of the scales range in scores from 0  
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58 to 100. A high score for a functional scale represents a high/healthy level of functioning whereas a high score for a  
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4 symptom scale or item represents a high level of symptomatology or problems. For more details on the scoring  
5 procedures see the EORTC QLQ-C30 Scoring Manual (29). Participants were classified as having better QOL if their  
6 scores were higher than 50 and poor QOL if it was lower than 50.  
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### 9 10 **Other variables**

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12 Covariates were age, sex, race/ethnicity, socioeconomic status, education level, marital status (married vs single  
13 or divorced/widowed), insurance status, years with cancer, smoking habit, alcohol use, physical activity, treatment  
14 regimen, district, BMI and history of coexisting illnesses. Because coexisting illnesses may affect survivors QOL,  
15 we measured coexisting illnesses conditions by asking cancer survivors whether they had ever been told by a  
16 physician that they had chronic diseases, including hypertension, hyperlipemia, hyperuricemia, diabetes, heart  
17 disease, stroke, respiratory disease, digestive system disease, and skeleton system diseases. All covariates were  
18 determined at the time of the survey.  
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### 26 **Statistical Analysis**

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28 To determine whether a summed unidimensional health literacy scale could be used, item response theory (IRT)  
29 was used to evaluate the item parameter (discrimination parameter, threshold parameter), item characteristic curve  
30 (ICC) and item information curve (IIF). Since the item responses are classified into ordered polytomous categories,  
31 the Graded Response Model (GRM) was used. For the participants answering only 1 or 2 of the 3 questions, the score  
32 for those questions was multiplied by 3 and 1.5, respectively (16).  
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39 Baseline characteristics were compared across levels of HL using  $\chi^2$  test for categorical variables and the  
40 Wilcoxon rank sum test for the non-normal continuous variables. Linear regression models were used to estimate the  
41 association between HL score and QOL after controlling for differences in participants' characteristics, including  
42 age, sex, race/ethnicity, marriage, education, income, insurance status, years with cancer, number of chronic disease,  
43 smoking habit, alcohol use, physical activity, treatment regimen, district and BMI. Logistic regression models were  
44 used to measure the independent relationship between HL and each of the QOL scale, while adjusting for other  
45 potentially confounding survivor characteristics.  
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53 The IRT analyses were conducted using the MULTILOG version 7.03. Other statistical analyses were performed  
54 with SAS version 9.4 for each analysis, the null hypothesis was evaluated at a 2-sided significance level of 0.05.  
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### 56 **Patient and public involvement**

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58 Patients and public were not involved in the development of the research question or in the design of the study.  
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## Results

Among 4713 cancer survivors surveyed, 4610 responded, for a 97.81% response rate. For 4589 of the 4610 participants, at least 1 HL question was available in the survey; these participants composed our study sample and the valid rate was 99.5%.

The summed HL scale was measured by using all 3 HL questions. The correlations of single items to the total were 0.73, 0.70, and 0.75 for questions 1 to 3, respectively. Figure 1 shows the IRT models and test information for the total sample and illustrates the implications of the item parameters for the response probabilities for different levels of health literacy. All items had high discrimination parameters, except for Item 3, 'How often do you have problems learning about your medical condition because of difficulty reading hospital materials', which had moderate discrimination ( $a=0.88$ ) but still satisfy the condition of  $a>0.75$ . The difficulty parameters (Threshold) increased monotonically across rating scale categories for all items, ranging from -1.81 to 3.94, indicating that the 3 HL questions discriminate well. Among the 4589 participants in the study, the mean HL score was 6.3 (range, 3-15). As table 1 shows, one hundred fifty-nine participants (3.5%) had low HL (HL score, 11-15). Participants with low HL were more likely than participants with adequate HL to be older, to have received only some middle school education or less, and to have had a little exercise.

Table 2 presents the bivariate relationships between predictors of QOL and cancer survivors' global health status. The HL score, age, sex, marriage, years with cancer, number of chronic diseases, smoking habit, alcohol use, physical activity, district, and BMI were all associated with QL. After adjustment for other potentially confounding factors, marriage, years with cancer, and smoking habit were no significant differences among levels of HL. For each 1-point decrement in the HL score, the QL value increased by 2.07 ( $P<.001$ ).

Cancer survivors with adequate HL were more likely to receive higher scores on the functional scale and lower scores on symptom compared to those with low HL. According to the recommendation (30), a difference on the 0–100 scale of more than 5 points were considered as a clinically important difference. As can be seen from the data in Figure 2 that there had a clinically significant difference between survivors with adequate HL and survivors with low HL, in terms of global health status (difference of adequate HL vs low HL [diff], 9.05), role function (diff: 5.2), emotional function (diff: 5.17), cognitive function (diff: 7.13), social function (diff: 7.49), insomnia (diff: -8.8), and financial difficulties (diff: -8.71).

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4 Eighty-three percent of cancer survivors with adequate HL and 65% of cancer survivors with low HL reported that  
5 they had a good global health status (unadjusted odds ratio [OR], 2.75; 95% confidence interval [CI], 1.97-3.84;  
6 P<.001). After confounders were adjusted, cancer survivors with adequate HL were more likely to report a better  
7 global health status (adjusted OR, 2.81; 95% CI, 1.94-4.06; P<.001) (Table 3). The extent of the associations between  
8 HL and other scales of QOL, including four functional scales (physical, emotional, cognitive and social functioning),  
9 three symptom scales (fatigue, pain, and nausea/vomiting), and three single-item (insomnia, appetite loss, and  
10 financial difficulties), was similar to that of global health status and all had a statistical significance (Table 3).  
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## 20 Discussion

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22 Our study demonstrates that inadequate HL as assessed by 3 brief screening questions was present in less than 1  
23 in 25 cancer survivors in Shanghai Cancer Rehabilitation Club. And inadequate HL was an independent predictor of  
24 poor QOL and was associated with a lower level of functioning and a higher level of symptomatology or problems.  
25 The association between HL and QOL that we observed is significant from a clinical and public health perspective.  
26 These findings highlight a potential target for interventions to improve the overall quality of life for cancer survivors.  
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32 To our knowledge, few studies had demonstrated the association between HL and QOL among cancer survivors  
33 using the 3 brief screening questions in China. Prior research studies have used more complex and extensive  
34 questionnaires to measure HL, such as the Rapid Estimate of Adult Literacy in Medicine (22, 31), Cancer Health  
35 Literacy Test-30 (CHLT-30) (32), the Short-Form Test of Functional Health Literacy in Adults (S-TOFHLA) (5, 33,  
36 34), et al. which are also impractical for use in busy clinical settings. Despite differences in the nature of HL  
37 assessment techniques, our results are consistent with those of previous studies that identified inadequate HL as a  
38 risk factor for QOL among cancer survivors (5, 14, 35). Our results showing a higher adequate HL level are in contrast  
39 to those from other Chinese studies (36, 37) which found a lower adequate HL in the Chinese population. This might  
40 because the participants we surveyed were all come from the Cancer Rehabilitation Club in Shanghai. The club (38)  
41 firmly advocates “anti-cancer groups, beyond life”, and organizing a variety of rehabilitation activities to make  
42 patients feel full confidence in their rehabilitation. Participants in the club will have their HL level gradually improved.  
43 This might be the reason why our results were higher than in other studies.  
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56 The result of the study showed that many factors were associated with QOL, including HL score, age, sex, number  
57 of chronic disease, alcohol intake, physical activity, district, and BMI among cancer survivors, which almost in line  
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4 with previous studies (39). Continuous HL score was found to be associated with QOL. The higher of HL scores  
5 (indicating limited HL), the lower of QOL (35). Gender was found to be a determinant of QOL and males were more  
6 likely have poor QOL compared to females. Study showed that older survivors reported higher QOL, however, there  
7 existed some research reported that overall QOL increased with age (40). There was strong association between QOL  
8 and chronic disease, and QOL was lower in the presence of survivors with chronic diseases (41). Physical activity  
9 was found to be positively associated with QOL. And those living in urban area were more likely to have better QOL  
10 than those living in rural area. Survivors with higher BMI had higher overall QOL when controlling for confounders,  
11 which was slightly different from some studies conducted among female that reported that higher BMI was associated  
12 with QOL (42, 43).

13  
14 Besides that, the positive relationship between HL and scales of HRQOL were existed regardless of how HL or  
15 HRQOL was operationalized (continuous or categorical). Our study showed that cancer survivors with adequate HL  
16 had nearly 3 times the odds of having a better QOL than cancer survivors with inadequate HL and the same trend  
17 could be found in other functional subscales. In symptom subscales, those with adequate HL were more likely to  
18 have slight symptoms compared with those with limited HL. That's largely because information needs and understand  
19 of the person living with a chronic condition is critical for the optimal management (8). Kim et al. (44) indicated that  
20 low health literacy prostate cancer patients may have hindered patient involvement in shared decision-making with  
21 a physician. Those who had inadequate HL may have difficulty in understanding medical information given by  
22 provider, managing their treatment plan, and adherence to cancer treatment regimens, resulting in exacerbated  
23 treatment-related symptoms (35). Whereas, those who had adequate HL have better chance to acquire health  
24 information about this kind of disease as well as understand doctors' advice, and adopt a healthy lifestyle, such as  
25 drink less alcohol and exercise regularly.

26  
27 From the public health perspective, HL is an important factor in ensuring significant health outcomes. (35, 45, 46)  
28 Inadequate HL may contribute to the disproportionate burden of cancer-related problems among disadvantaged  
29 populations. The United Nations ECOSOC Ministerial Declaration of 2009 provided a clear mandate for action "call  
30 for the development of appropriate action plans to promote health literacy" (2). The 9<sup>th</sup> Global Conference was held  
31 in Shanghai, China (2016) and addressed the determinants of health through good governance, health cities, health  
32 literacy, and social mobilization (2). Therefore, improving cancer survivors' health literacy is an important target for  
33 improving their QOL.

## Limitation

Several limitations should be considered in the interpretation of our findings. First, it was a cross-sectional study and causal inferences could not be drawn due to the cross-sectional design employed, and interventions should be conducted in the further research. Second, we didn't use the questionnaire of Chinese residents health literacy monitoring and other complex tool to evaluate the HL, and the 3 brief questions may reflect other constructs, but the 3 brief questions can easily be incorporated into the clinical routine work and are useful to identify high-risk patients. Third, this study might only have a good representativeness of the cancer survivors in Shanghai Cancer Rehabilitation Club and may not be generalizable to non-members of Cancer Rehabilitation Club. However, as discussed above, if the effect of inadequate HL would be weaken in this participants, it may be greater in different populations.

## Conclusions

In summary, inadequate health literacy as evaluated by 3 brief screening questions is independently associated with poor QOL in cancer survivors. Efforts should focus on developing and evaluating interventions to improve QOL among cancer survivors with inadequate HL.

## DECLARATIONS

**Ethics approval and consent to participate:** Informed consent was obtained from all participants before enrollment. The protocol was approved by the committee of Public Health School of Fudan University (protocol number IRB # 2017-05-0621).

**Consent for publication:** Not applicable

**Availability of data and material:** Please contact author for data requests.

**Competing interests:** None declared

**Funding:** Not applicable

**Authors' contributions:** Juan Xia carried out the field investigation, participated in the design of the study, performed the statistical analysis and drafted the manuscript. Peng Wu in charge of the process of submission and revision of this paper. Peng Wu, Qing-Long Deng, Rui Yan, Ren-Ren Yang and Bing-hui Lv participated in the field investigation and data collection. Ji-Wei Wang and Jin-Ming Yu designed and coordinated the study and revised the manuscript. All authors read and approved the final manuscript.

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**Acknowledgements:** We wish to thank Furong Tang, Donghui Yu, Mengxue Yin and some other volunteers who contributed to this survey. We also wish to thank the thousands of cancer survivors who were willing to complete the survey.

For peer review only

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36 **Figure Title:**

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38 Figure 1. Item Characteristic Curve and Test Information Curve for the 3 established screening questions

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40 Figure 2. Unadjusted QOL scores for cancer survivors with inadequate and adequate health literacy  
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Table 1. Characteristics of respondent stratified by HL levels\*

Characteristics	Total (N=4589)	Level of Health Literacy		P value
		Adequate (n=4430)	Inadequate (n=159)	
Age, M (Q1,Q3), y	62.0 (57.04,66.53)	62.0 (57.00,66.53)	62.52 (58.37,68.39)	0.0485
Years with cancers, M (Q1,Q3)	6.09 (3.50,10.50)	6.09 (3.50,10.50)	5.92 (3.50,10.58)	0.6258
Sex, No.(%)				0.9424
Male	1057 (23.03)	1020 (96.50)	37 (3.50)	
Female	3532 (76.97)	3410 (96.55)	122 (3.45)	
Race				0.8644
Hanzu	4544 (99.28)	4386 (96.52)	158 (3.48)	
Marriage				0.2192
single	129 (2.81)	121 (93.80)	8 (6.20)	
married/ cohabitation	3989 (86.93)	3853 (96.61)	136 (3.41)	
divorced/widowed/ separated	471 (10.226)	456 (96.82)	15 (3.18)	
Annual income, ¥				0.0534
<5000	4134 (91.89)	3987 (96.44)	147 (3.56)	
≥5000	365 (8.11)	359 (98.36)	6 (1.64)	
Family income				0.8296
<5000	3086 (70.07)	2979 (96.53)	107 (3.47)	
≥5000	1318 (29.93)	1274 (96.66)	44 (3.34)	
Education				0.0003
Middle school or less	4021 (87.62)	3867 (96.17)	154 (3.83)	
High school or college	568 (12.38)	563 (99.12)	5 (0.88)	
Insurance status				0.8159
Uninsured	645 (15.55)	623 (96.59)	22 (3.41)	
Medicare	3504 (84.45)	3378 (96.40)	126 (3.60)	
Treatment regimen				0.2753
Chemotherapy	661 (14.44)	641 (96.97)	20 (3.03)	

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4	Radiotherapy	74 (1.62)	68 (91.89)	6 (8.11)
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6	Operation	931 (20.34)	902 (96.89)	29 (3.11)
7				
8	Chemotherapy & Radiotherapy	162 (3.54)	155 (95.68)	7 (4.32)
9				
10	Chemotherapy & Radiotherapy	897 (19.59)	870 (96.99)	27 (3.01)
11				
12	& Operation			
13				
14	Chemotherapy & Operation	1658 (36.22)	1594 (96.14)	64 (3.86)
15				
16	Biotherapy	69 (1.51)	66 (95.65)	3 (4.35)
17				
18	Number of Chronic disease			0.3564
19				
20	0	1238 (26.98)	1203 (97.17)	35 (2.83)
21				
22	1-3	2735 (59.60)	2634 (96.31)	101 (3.69)
23				
24	>3	616 (13.42)	593 (96.27)	23 (3.73)
25				
26	Smoking habit			0.5284
27				
28	Never	3841 (83.70)	3711 (96.62)	130 (3.38)
29				
30	Former	598 (13.03)	573 (95.82)	25 (4.18)
31				
32	Current	150 (3.27)	146 (97.33)	4 (2.67)
33				
34	Current alcohol use			0.0637
35				
36	None	4264 (92.92)	4113 (96.46)	151 (3.54)
37				
38	Light to moderate	215 (4.69)	213 (99.07)	2 (0.93)
39				
40	Heavy	110 (2.40)	104 (94.55)	6 (5.45)
41				
42	Body mass index#			0.4593
43				
44	<18.5	233 (5.16)	229 (98.28)	4 (1.72)
45				
46	18.5-23.9	2342 (51.85)	2258 (96.41)	84 (3.59)
47				
48	24.0-27.9	1546 (34.23)	1492 (96.51)	54 (3.49)
49				
50	≥28.0	396 (8.77)	380 (95.96)	16 (4.04)
51				
52	Physical activity			0.0264
53				
54	No	1038 (22.64)	991 (95.47)	47 (4.53)
55				
56	1-4 times per week	2493 (54.37)	2406 (96.51)	87 (3.49)
57				
58	≥5 times per week	1054 (22.99)	1029 (97.63)	25 (2.37)
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\* Data are given as percentages unless otherwise indicated.

# Calculated as weight in kilograms divided by the square of height in meters.

Table 2. Relationship between survivors' characteristics and QOL

Predictor	Unadjusted		Adjusted*	
	Coefficient $\tau$	P Value	Coefficient $\tau$	P Value
HL score	-2.11	<0.0001	-2.07	<0.0001
Age	-0.25	<0.0001	-0.16	0.0053
Sex, female	-3.92	<0.0001	-5.02	0.0002
Race/ethnicity	2.10	0.5854	6.41	0.1819
Marriage	-3.01	0.0051	-2.14	0.0710
Education	-0.28	0.6316	-1.38	0.3190
Annual income	0.42	0.7664	0.81	0.6044
Family income	-0.03	0.9694	0.53	0.5521
Insurance status	-1.67	0.1263	-0.09	0.9346
Years with cancer (per year)	-0.23	0.0002	-0.04	0.5401
Number of Chronic disease	-5.79	<0.0001	-4.87	<0.0001
Smoking habit	1.35	0.015	-1.23	0.1210
Alcohol intake	3.38	<0.0001	2.07	0.0240
Physical activity	4.07	<0.0001	3.15	<0.0001
Treatment regimen	-0.004	0.985	0.16	0.4474
District	0.63	<0.0001	0.48	<0.0001
BMI	1.14	0.0305	2.18	<0.0001

\* Adjusted for age, sex, race, marriage, income, education, insurance, years with cancer, treatment regimen, district, number of chronic disease, smoking habit, alcohol use, physical activity and BMI.

$\tau$  All coefficients correspond to a change in QOL score for unit change of each covariate.

Table 3. Adjusted Odds Ratio of QOL for cancer survivors with inadequate vs adequate health literacy\*

QOL	Survivors with poor QOL	Odds Ratio (95%CI)	P value
Global health status (QL)	788	2.81 (1.94-4.06)	<0.0001
Physical function (PF)	83	2.84 (1.18-6.87)	0.0205
Role function (RF)	53	2.70 (0.94-7.80)	0.0664
Emotional function (EF)	77	5.01 (2.37-10.58)	<0.0001
Cognitive function (CF)	128	4.07 (2.18-7.61)	<0.0001
Social function (SF)	250	3.59 (2.19-5.88)	<0.0001
Fatigue (FA)	425	2.63 (1.68-4.12)	<0.0001
Nausea/Vomiting (NV)	52	5.39 (2.17-13.38)	0.0003
Pain (PA)	296	2.37 (1.41-3.97)	0.0011
Dyspnea (DY)	152	1.86 (0.88-3.94)	0.106
Insomnia (SL)	475	2.41 (1.56-3.74)	<0.0001
Appetite loss (AP)	91	3.84(1.84-8.03)	0.0003
Constipation (CO)	188	1.06 (0.45-2.46)	0.8995
Diarrhea (DI)	114	2.11 (0.95-4.71)	0.0679
Financial difficulties (FI)	747	2.73 (1.88-3.97)	<0.0001

\*Adjusted for age, sex, race, marriage, income, education, insurance, years with cancer, treatment regimen, district, number of chronic disease, smoking habit, alcohol use, physical activity and BMI

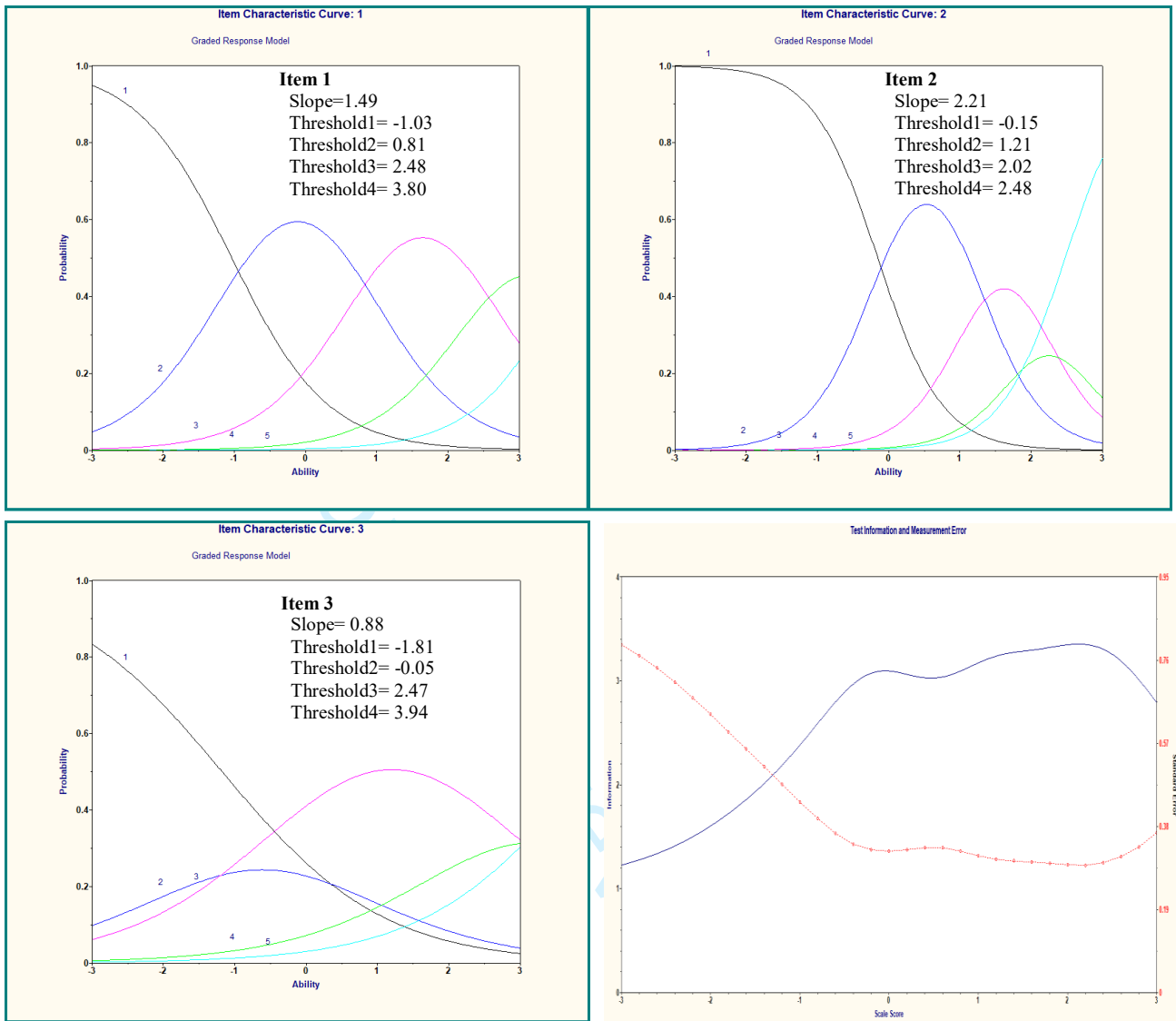


Figure 1. Item Characteristic Curve and Test Information Curve for the 3 established screening questions

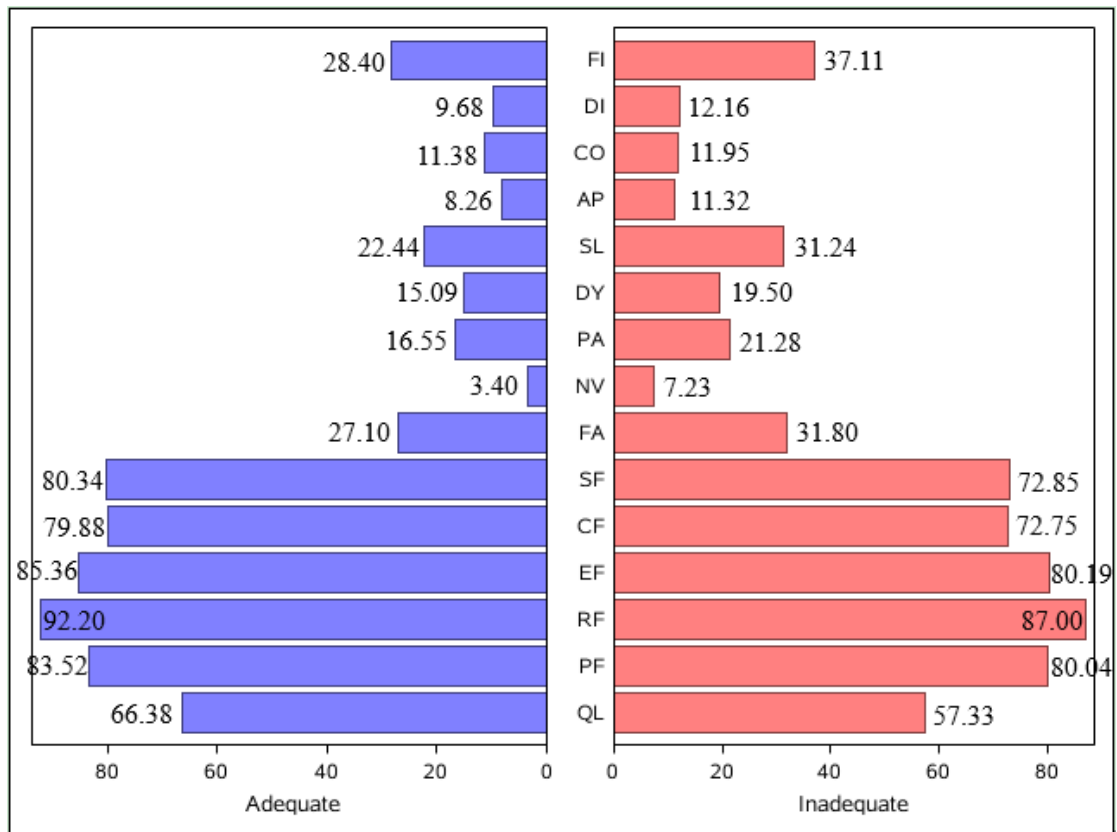


Figure 2. Unadjusted QOL scores for cancer survivors with inadequate and adequate health literacy



STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (Page 2, Line 1) (b) Provide in the abstract an informative and balanced summary of what was done and what was found (Page 2, Line 17)
<b>Introduction</b>		
Background/rationale (Page 3, Line 9-Page 4, Line 16)	2	Explain the scientific background and rationale for the investigation being reported
Objectives (Page 4, Line 17-22)	3	State specific objectives, including any prespecified hypotheses
<b>Methods</b>		
Study design (Page 4, Line 26)	4	Present key elements of study design early in the paper
Setting (Page 4, Line 26-Page 5, Line 1)	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants (Page 5, Line 2-13)	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants
Variables (Page 4, Line 18-Page 6, Line 10)	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement (Page 4, Line 18-Page 5, Line 7)	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias (Page 10, Line 1)	9	Describe any efforts to address potential sources of bias
Study size (Page 5, Line 10-13)	10	Explain how the study size was arrived at
Quantitative variables (Page 5, Line 18-20)	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods (Page 6, Line 11-25)	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses
<b>Results</b>		
Participants (Page 7, Line 1-3)	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram
Descriptive data (Page 7, Line 4-14)	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest
Outcome data	15*	Report numbers of outcome events or summary measures
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted

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(Page 7, Line 15- Page 8, Line 6)		estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(b) Report category boundaries when continuous variables were categorized
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
<b>Discussion</b>		
Key results (Page 8, Line 8-12)	18	Summarise key results with reference to study objectives
Limitations (Page 10, Line 1-8)	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation (Page 8, Line 13-Page 9, Line 19)	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability (Page 9, Line 20-26)	21	Discuss the generalisability (external validity) of the study results
<b>Other information</b>		
Funding (Page 10, Line 23)	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

\*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).