Trajectory patterns and factors influencing perinatal fatigue among Chinese women from late pregnancy to six months after delivery

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Background. Perinatal fatigue among women is related to the clinical outcomes of mothers and infants. Perinatal fatigue changes over time, and the trajectory varies according to the predictors and outcomes of the mothers. This, however, has not been documented in any study.

Objectives. This study aimed to identify and characterize the trajectory patterns of perinatal fatigue among women from late pregnancy to six months after delivery.

Methods. We used growth mixture modeling to estimate the trajectory of perinatal fatigue at 28 gestational weeks (T0), 37 gestational weeks (T1), three days (T2), one week (T3), six weeks (T4), and six months (T5) after delivery with (n=1030). The Mann-Whitney U test and binary logistic regression were used to tie the selected trajectory classes to predictors and outcomes.

Results. There were two distinct patterns of perinatal fatigue in women: "persistently high" (11.1 %, n=114) and "persistently low" (88.9 %, n=916). Levels of perinatal fatigue among women in the "persistently high" group were higher than those in the "persistently low" group across the six measurements. Complications, fatigue at T0, and employment status in late pregnancy were all significant predictors of trajectories. Additionally, the "persistently high" group had a greater prevalence of difficult baby care and weight retention and a lower prevalence of exclusive breastfeeding.

Conclusions. Our study proved the heterogeneity and characteristics of perinatal fatigue among women. Future research should concentrate on developing intervention packages targeted at specific individuals in order to alleviate perinatal fatigue in women.

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Keywords. perinatal fatigue; trajectories; predictors; outcomes; growth mixture modeling

Introduction

Perinatal fatigue, which includes both pregnancy and postpartum fatigue, is one of the most frequently reported complaints among childbearing women[1,2]. And perinatal fatigue is related to adverse clinical outcomes for women and infants. Prenatal fatigue could increase rates of pregnant morbidity[3], cesarean section[4], preterm birth, and even postpartum depression[5]. Postpartum fatigue may delay the initiation of breastfeeding[6], reduce mother-infant attachments[7] and even cause postpartum depression[8]. Collectively, comprehensive understandings of perinatal fatigue among women are needed.

However, longitudinal data on perinatal fatigue in women are quite scarce. Longitudinal studies have mainly focused on the levels and courses of perinatal fatigue among the population over time, which may obscure individual differences[9,10,11]. Only one study, Kuo's investigation, has reported perinatal fatigue trajectories among 121 women from the late pregnancy to one week postpartum[12]. Kuo's analysis clarified the heterogeneity of fatigue among women from pregnancy to postpartum periods. However, class 3 of the perinatal fatigue trajectories in Kuo's study only had nine women due to its limited sample sizes. And it only measured perinatal fatigue among women until one week postpartum, which shortened perinatal periods. Thus, it is necessary to gain understanding into whether and how perinatal fatigue trajectories emerge in larger samples of women throughout longer perinatal periods.

Investigating the factors that contribute to prenatal fatigue trajectories is also critical for intervention development. Few aspects of perinatal fatigue trajectories have been reported, though multiple factors are associated with the perinatal fatigue[13,14]. In this study, the theoretical framework for factors influencing perinatal fatigue was according to Pugh's framework[15]. Pugh's framework used the Classification of Nursing Diagnosis definition of fatigue: "An overwhelming sustained sense of exhaustion and decreased capacity for physical and mental work." In this framework, related factors of perinatal fatigue were categorized into situational, physiologic, psychologic, and performance factors **(Figure 1)**. Investigating the factors that influence

63 perinatal fatigue trajectories may provide to a better understanding of how to avoid or reduce
64 perinatal fatigue in women.
65 From late pregnancy to six months after birth, this prospective, longitudinal study assessed
66 perinatal fatigue in women six times.The particular objectives of this study were to detect and
67 define the trajectory patterns of perinatal fatigue in women from late pregnancy to six months
68 after birth.Extending our understanding of the identified perinatal fatigue trajectory types and
69 their related components may help to improve clinical management for perinatal fatigue.

Materials & Methods

Study Design and Settings

This study is a prospective, longitudinal study, conducted between December 2020 and September 2021. Participants were asked to fill out questionnaires six times, namely, 28 gestational weeks(T_0), 37 gestational weeks(T_1), three days postpartum(T_2), one week postpartum(T_3), six weeks postpartum(T_4), and six months postpartum(T_5). This work was approved by the Obstetrics and Gynecology Hospital attributed to Fudan University (No.2020-191).

Participants

We used the continuous enrollment method to find eligible participants between December 2020 and January 2021. Pregnant woman at (28+0, 29+6) weeks was scanned and recruited. The exclusion criteria were women with (a) diagnosed depression before; (b) severe health problems such as heart failure; (c) twins or multiples. All women signed informed consent.

Measurements

Perinatal fatigue was measured by the Postnatal Accumulated Fatigue Scale (PAFS). Professor Emi Mori firstly published the scale in 2016[16]. Each of the 13 items of this scale has a three-point rating from 0-3 (0 = rarely, 1 = sometimes and 3 = often). These 13 items are divided into three dimensions (physical, emotional, and cognitive), for example, "I feel unfocused" (cognitive). The total score ranges from 0 to 39, with higher scores indicating higher fatigue levels. This scale has good reliability and validity in the former study[16]. In this study, we obtained authorization from Professor Emi Mori regarding the use of the PAFS, and translated the Japanese version of PAFS into a Chinese version. The Chinese version of PAFS scale also has good reliability (Cronbach's alpha=0.823～0.908) and validity (KMO=0.801～0.91) in this sample. Data of perinatal fatigue were collected six times from T_0 to T_5.

Self-made questionnaires collected data of situational factors at T_0 and T_2. At T_0, we collected data of maternal age, parity(primipara, multipara), employment (employed, unemployed), an

education level (<college, college, >college), monthly family income (<¥10000, ¥10000~20000, >¥20000) and residency (urban, suburban). Also, we collected data of planned pregnancy (yes, no), prenatal training (yes, no), sleep duration per day (<six hours[hrs], six to eight hrs, >8hrs), and sleep quality at this time. Of them, sleep quality was evaluated by asking women, "Please score your sleep quality in the past 24 hours, ranging from 0 to 10, and 0 score means very dissatisfied, and 10 scores mean very satisfied." Besides, fetus gender (boys, girls) was obtained by medical records at T_2.

Self-made questionnaires were also used to collect data of physiologic factors at T_0 and T_1. Maternal height, prenatal weight, weight at T_0, gestation, complication, pain, and fatigue were collected at T_0. Of them, the pain was measured by asking one question: "Please score your pain in the past week, ranging from 0 to 10, and 0 score means no pain and 10 scores mean very painful." Based on these data, we calculated prenatal body mass index (BMI), BMI at T_0, weight gain at T_0 (weight at T_0 minus prenatal weight), and BMI gain at T_0 (BMI at T_0 minus prenatal BMI). And "T_1-T_0 fatigue" was equal to PAFS fatigue score at T1 minus that at T0, similar calculations were used for (T_2-T_1)/(T_3-T_2)/(T_4-T_3)/(T_5-T_4) Fatigue.

One maternal psychologic factor, anxiety, was measured at T_0 by asking participants: "How anxious are you in the past week? Choose a number between 0-10 to express the extent of your anxiety, 0 for no anxiety, 1 to 3 scores for mild anxiety, 4 to 6 scores for moderate anxiety, 7 to 9 scores for severe anxiety, and 10 scores for extreme anxiety."

Performance factors among women were regarded as outcomes of perinatal fatigue in this study, which were all collected at T_5, including difficult baby care (yes, no), exclusive breastfeeding (EBF; yes, no), and weight (kilogram, M±SD). Also, weight retention was defined as "yes" if weight at T_5 was more than prenatal weight, vice versa as "no."

Statistical analysis

Only data of participants who completed at least three follow-ups were included in the analysis. Data analysis was carried out in the following two parts based on the two objectives of this study.

In the first part, we used growth mixture modeling (GMM) to identify the trajectory of perinatal fatigue. GMM is an advanced, person-centered analysis to identify heterogeneous subgroups that comprise distinct courses across time[17]. The time intervals were uneven from T_0 to T_5, namely, 0 weeks (T_0-T_0), 8 weeks (T_1- T_0), 12 weeks (T_2- T_0), 13 weeks (T_3- T_0), 18 weeks (T_4-T_0), 36 weeks (T_5-T_0), respectively. Thus, the time score of T_0 to T_5 was fixed here at 0, 8, 12, 13, 18, 36, representing the equidistant time model. A robust maximum likelihood estimator was used for model estimation. Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and Sample-Size Adjusted BIC (aBIC) were used as the model fit goodness statistics, with smaller values suggesting better model fit. Entropy was used to evaluate the accuracy of classification. The closer the entropy was to 1, the higher the class accuracy was. Likelihood Ratio Test (LRT) compared an n-class model with an n-1-class model, where a significant P value indicated a considerable improvement in the n-class model and thus rejected n-1-model rationally. In this study, the Lo-Mendell-Rubin (LMR) and Bootstrap Likelihood Ratio Test(BLRT) were also used for model comparison. Bayesian posterior probability was applied to export latent trajectory classes after a best-fit model was determined. In this part, GMM was performed with Mplus 8.3. In addition, a rank-sum test was used to examine differences in fatigue scores at six times and during five adjacent times between the trajectories. And $p<0.05$ were preliminary remarked as positive.

In the second part, to characterize the trajectory of perinatal fatigue, the Mann-Whitney U test, and binary logistic regression were implemented. We calculated the Z-score of skewness and kurtosis for all continuous variables (Supplemental Table 1). Only gestation at baseline was normally distributed, but it does not have homogeneity of variance. Thus, the Mann-Whitney U test was used to compare differences between all variables, including continuous variables (such as maternal age) and categorical variables (such as monthly family income). Variables with $p<0.05$ were preliminary remarked as positive between the trajectory classes. To further describe characteristics of perinatal fatigue trajectory, binary logistic regression (Forward: LR) was

applied. The latent trajectory classes as the dependent variable and positive potential predictors as independent variables in the regression model. And variables with $p<0.05$ in the regression model were regarded as predictors of perinatal fatigue trajectory. In this part, performance factors were not included in the regression model because they were considered outcomes rather than potential predictors. SPSS version 23.0 was used for Mann-Whitney U and binary logistic regression.

Results

Of 1150 women who met initial eligibility criteria and consented to participation, a total of 1030 women who completed at least three follow-ups were included in this report. Cases included in each visit were 1009(T_0), 917(T_1), 970(T_2), 781(T_3), 563(T_4), and 779(T_5), respectively(**Figure 2**). The average age was 30.47 (SD 4.01) years in this study. Besides, 75.8% of these women were primiparas, 82.1% had a college degree, 80.9% were employed, and 87.1% had high monthly family income(≥￥10000). No significant difference of Basic information was found between included and non-included subjects (Supplemental Table 2).

Identifying Perinatal Fatigue Trajectories

Table 1 shows the GMM of one to five fatigue trajectory classes, including 1-class model, 2-class model, 3-class model, 4-class model, and 5-class model. All models can be supposed to obtain the best maximum likelihood. The best fit model is based on different model fit indices: (1)the AIC, BIC, and ABIC are smaller; (2)the entropy is closer to 1; (3)LMR and BLRT are both significant. Collectively, the 2-class model was the best fit model in this study.

The mean intercept factor of Class 1(12.318) was higher than that of Class 2 (10.118), and the variance of the intercept factor between these two classes was 13.586 ($p<0.001$), indicating a relatively higher initial fatigue score in Class 1 than Class 2. The average slope factors of Class 1 and Class 2 were 0.306 ($p<0.001$) and -0.110 ($p<0.001$), indicating that Class 1's fatigue score increased significantly over time while Class 2's decreased significantly over time. In addition, the trajectories of fatigue scores were also visually shown in **Figure 3**. Thus, Class 1 and Class 2 were named as the "persistently high" group (11.1%; n=114) and "persistently low" group (88.90%; n=916), respectively.

Table 2 showed that fatigue scores had inconsistent growth tendency between different adjacent times. Firstly, an interesting finding was that the fatigue score in the "persistently high" group increased significantly faster than the "persistently low" group from T_0 to T_1 ($p=0.001$). And no significant differences in fatigue scores were found from T_1 to T_2, from T_2 to T_3, and from T_3 to

T_4. Combined **Table 1** with **Figure 1**, from T_0 to T_4, fatigue scores in both classes presented similar upward (from T_0 to T_3) and downward (from T_3 to T_4) trends. Oppositely, fatigue scores showed a strong upward trend from T_4 to T_5 in the "persistently high" group, whereas a solid downward trend in the "persistently low" group($p<0.001$). In addition, for the "persistently high" group, the peak fatigue score showed at T_5, followed by that at T_3. For the "persistently low" group, the peak of fatigue score showed at T_3.

Characteristics of Perinatal Fatigue Trajectories

Table 3 summarizes the two groups' descriptive statistics of related factors (situational, physiologic, psychologic, and performance factors). For situational factors, individuals in the "persistently high" group were less employed ($p= 0.002$) and had worse sleep quality($p<0.001$) at T_0 than those in the "persistently low" group. For physiologic factors, women in the "persistently high" group had smaller prenatal weight ($p=0.014$), weight at T_0 ($p=0.014$), BMI at T_0 ($p=0.036$), more complication ($p<0.001$), and severer fatigue at T_0 ($p<0.001$) than those in "persistently low" group. For psychologic factors, more people in the "persistently high" group reported anxiety status with scores between 7-10 at T_0 than the "persistently low" group did($p <0.001$). Binary logistic regression was used to analyze the relationships between potential factors and the perinatal fatigue trajectory. The regression model was summarized in **Table 4**. In the model, perinatal fatigue trajectory classes were the dependent variable and coded as 1 = "persistently high" group and 0 = "persistently low" group. And all factors significantly differed between the two classes were regarded as independent variables. But a high correlation was found between fatigue at T_0 and sleep quality ($r = 0.38$, $p< 0.001$), fatigue at T_0 and anxiety ($r = 0.36$, $p< 0.001$), BMI at T_0 and prenatal weight ($r = 0.79$, $p< 0.001$), and BMI at T_0 and Weight at T_0 ($r = 0.87$, $p< 0.001$). Thus, only employment (1= “employed” and 0= “unemployed”), complication (1= “yes” and 0= “no”), fatigue at T_0, and BMI at T_0 from 878 cases were introduced into the final model. The $\chi 2$ test of the final model was significant ($P < 0.001$), and the Hosmer and Lemeshow test indicated an acceptable model fit with $p=0.417$. As a result, the final model showed three

predictors of perinatal fatigue trajectories, i.e. complication (odds ratio [OR], 2.779, 95% confidence interval [CI],1.641~4.706), fatigue at T0 (OR, 1.086, 95% CI, 1.042~1.132) and employment (OR, 0.544; 95% CI, 0.310~0.954).

In addition, **Table 3** also showed differences in the performance factors between the two groups. The percentages of patients with difficult baby care (36.8% VS 16.9%; $p<0.001$) and weight retention(56.8% VS 40.9%; $p=0.001$) were significantly higher in the "persistently high" group than the other group at T_5. Also, fewer people reported exclusive breastfeeding (EBF, 32.6%VS 47%; $p=0.002$) in the "persistently high" group than the other group at T_5.

DISCUSSIONS

Our study addressed previously unresolved gaps in the literature by identifying and describing the perinatal fatigue trajectory in a large sample from late pregnancy to six months postpartum. The findings of this study are critical for developing therapies to alleviate perinatal fatigue and improve mother and child clinical outcomes. We discovered two unique perinatal fatigue trajectories, namely "persistently high" (class 1, 11.1%) and "persistently low"(class 2, 88.9%). Additionally, we were the first to identify predicted markers for the perinatal fatigue trajectory, such as complication, fatigue at T_0, and employment. Additionally, women in the "persistently high" group experienced more adverse clinical outcomes than those in the "persistently low" group, including greater rates of difficult baby care and weight retention and lower rates of exclusive breastfeeding at T_5.

The identification of two distinct trajectories of prenatal fatigue in women confirmed the variability of perinatal fatigue. Though few research have shown this in pregnant women, prior investigations have identified two distinct fatigue trajectories in other populations, such as patients with cancer [18] and systemic sclerosis[19]. To our knowledge, only Kuo's study has investigated this in perinatal women, identifying three distinct trajectories (class 1, 44.6 %; class 2, 48.0 %; and class 3, 3.7%) of perinatal fatigue from late pregnancy to one week postpartum in 121 women[12]. Kuo's study detected one additional trajectory of perinatal fatigue in women than ours, which could be explained by the difference in measurement frequency, follow-up time, and sample size. Further research could be undertaken to confirm the trajectories of perinatal fatigue in women. Additionally, both our study and Kuo's study discovered that around one-tenth (11.1 % versus 7.4 %) of women were at high risk of experiencing extreme fatigue during their perinatal periods. Clinical personnel should identify and monitor these high-risk women more closely.

Notably, levels of perinatal fatigue were significantly higher in women classified as "persistently high" than in women classified as "persistently low" at all six time points from late pregnancy to

six months after delivery, which was consistent with prior study in other patients[19,20,21]. Additionally, the general level of prenatal fatigue grew dramatically with time in the "persistently high" group, whereas it decreased significantly in the "persistently low" group. This characteristic revealed that fatigue could be closely related to specific internal components.

Two time points have been identified for decreasing perinatal fatigue in women. One was one week postpartum for women classified as "persistently low." This conclusion is consistent with previous research emphasizing the critical role of one week postpartum in preventing perinatal fatigue[22,23]. The other was six months after birth for women classified as having "persistently high" blood pressure. On the other hand, Taylor's study found that perinatal fatigue reached a minimum six months following delivery[24]. And, in this study, the lowest level of perinatal fatigue was also six months after delivery in the "persistently low" group. This discrepancy may be explained by Taylor's study's analysis of the peak of perinatal fatigue using trends rather than trajectories. Thus, for the majority of women, the peak of perinatal weariness occurred one week after delivery, whereas for others, it occurred six months later. Future research could examine the factors that contribute to fatigue in women one week and six months following delivery.

In our investigation, a complication was identified as a risk factor for developing an elevated perinatal fatigue pattern. Women who experienced complications during late pregnancy, such as GDM[25] or hypertension[26], reported higher level of perinatal fatigue. Complications have also been implicated as risk factors for fatigue in pregnant women[27] and postpartum women[28]. Pathways for preventing or alleviating problems during late pregnancy should be researched further.

Another intriguing discovery was that exhaustion during late pregnancy may have an effect on how subsequent perinatal fatigue develops over time. Women who had increased fatigue throughout late pregnancy were more likely to fall into the "persistently high" category. Although this discovery has not been replicated in other studies, a similar pattern has been observed in prenatal depression[29]. Thus, health care providers could identify women at risk of

extreme exhaustion throughout the perinatal period as early as late pregnancy. Additionally, future research could develop predictive models to validate the prediction of perinatal fatigue in women based on exhaustion during late pregnancy.

Employment status was also associated with perinatal fatigue trajectories. This result suggested that women whose employment ratio was "persistently high" had a lower employment ratio during late pregnancy. Similarly to our employment finding, Chien's study found that unemployed women experienced considerably higher levels of weariness than other women during pregnancy[4]. This difference could be explained by job insecurity, which has been shown to impair psychological resilience[30]. As a result, women should be encouraged to seek employment rather than evade it in late pregnancy.

Additionally, to examine determinants of perinatal fatigue trajectories in women, we evaluated variations in performance parameters such as challenging baby care ratios, EBF, and weight retention at six months postpartum across the two trajectories. We discovered that the "persistently high" group had a larger proportion of challenging baby care than the other group, which is consistent with previous reports[7, 31]. Both of these investigations, however, were cross-sectional. Thus, our study was the first to reveal the detrimental effect of perinatal fatigue on six-month-old newborn care.

Does fatigue impact breastfeeding in women during their reproductive years? This issue has dogged health care providers for 15 years[6,32]. At six months postpartum, our study discovered that the ratio of exclusive breastfeeding was considerably lower in the "persistently high" group than in the "persistently low" group. Despite the cross-sectional nature of the study, earlier research has also demonstrated a detrimental relationship between postpartum fatigue and breastfeeding outcomes[33,34]. Logically, a higher level of postpartum fatigue among women was related to delayed breastfeeding initiation[35], decreased self-efficacy[23], and increased breastfeeding difficulties[36], all of which finally result in the termination of exclusive breastfeeding[37]. Our study was the first to establish a link between the prenatal fatigue trajectory

and the outcomes of exclusive breastfeeding six months after delivery, using a different study design and data analysis method than previous studies.

In addition, women need to escape weight retention[38,39,40]. At six months postpartum, 56.8 percent of women in the "persistently high" group experienced weight retention, compared to 40.9 percent of women in the "persistently low" group. To our knowledge, no other study has examined the association between perinatal fatigue and weight retention in postpartum women. Additional research is required to determine the association between fatigue and weight retention.

Several limitations should be highlighted regarding this investigation. To begin, our study stopped collecting data on perinatal fatigue six months after birth. Fatigue may occur in women who deliver more than a year after delivery[41,42]. A longer duration is necessary for examining the trajectories of perinatal fatigue in women. Second, the exact instrument used to assess perinatal fatigue was developed in 2016 and is not yet widely available. There is a need for reports on the implementation of the PAFS scale in perinatal mothers from diverse cultural backgrounds. Third, anxiety was the sole psychological element during the perinatal period, according to Pugh's theoretical model of perinatal fatigue. As a result, we focused only on anxiety as a psychological component of perinatal fatigue. And it was quantified using a single question rather than a predefined scale. Other psychologic variables, such as depression, should also be considered in future studies. Fourth, due to the researchers' limited time, only 574 women completed the six-week postpartum follow-up. Additionally, 92.5% of our participants were college or university graduates. Our findings should be reproduced in lower-education populations.

This study has a few implications for perinatal care research and practice. For research purposes, future empirical investigations could validate and change the perinatal fatigue trajectory classes among women from many cultural backgrounds. Additionally, more predictive models should be developed to investigate and illustrate prenatal fatigue predictors. This will allow for future investigation of the characteristics of prenatal fatigue and the development of more effective therapies targeting sub-populations for lowering individual perinatal fatigue. Additionally, future

research should examine the causal links between prenatal fatigue and clinical outcomes such as rates of difficult baby care, exclusive breastfeeding, and weight retention, thereby filling in the gaps in the data. In clinical practice, health care practitioners could undertake timely examinations of women early in their late pregnancy and screen out high-risk women who are at danger of experiencing extreme fatigue throughout the postnatal period.

To summarize, this study demonstrates the heterogeneity of perinatal fatigue in women by distinguishing two distinct perinatal fatigue trajectories: "persistently high" and "persistently low." Additionally, this study examined the characteristics of the two perinatal fatigue trajectories by finding three late-pregnancy predictors: complication, fatigue, and employment. Future research should focus on developing customized intervention packages based on these findings in order to alleviate women's perinatal fatigue.

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Figure 1

Framework for the study of mother's fatigue during the childbearing experience.

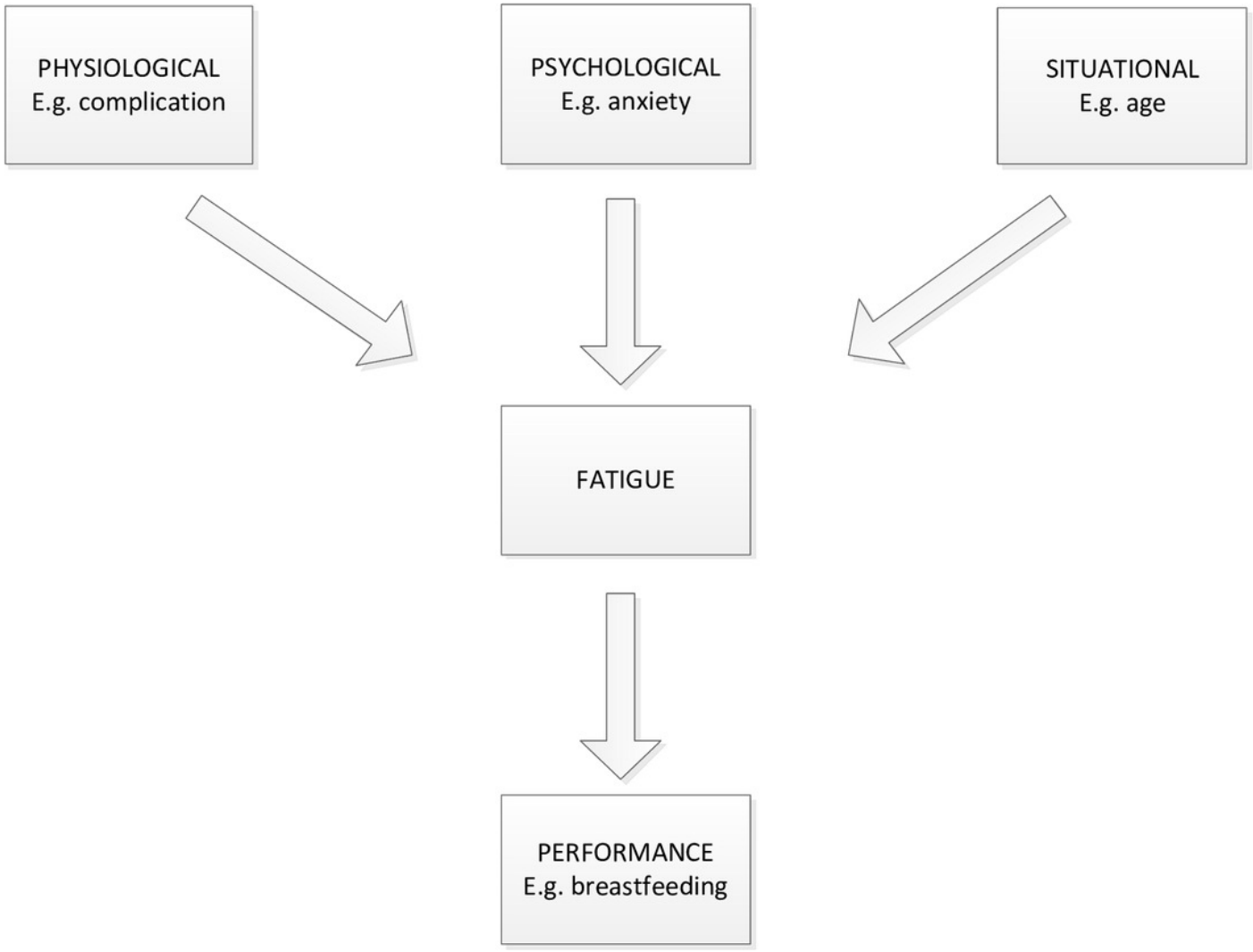

Figure 2

A flowchart of the participants in this study.

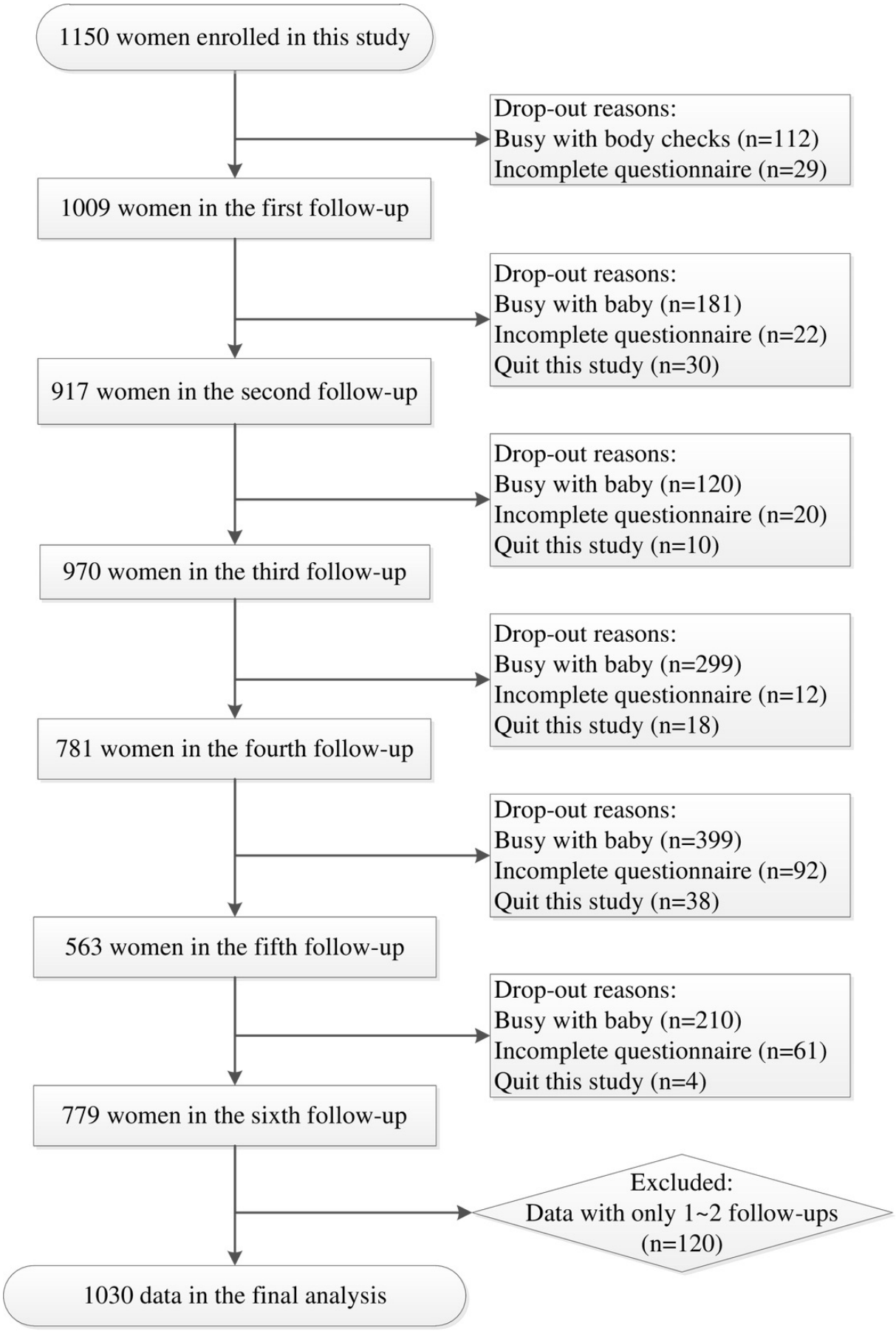
1150 women enrolled in this study
Drop-out reasons:
Busy with body checks (n=112)
Incomplete questionnaire (n=29)
1009 women in the first follow-up
Drop-out reasons:
Busy with baby (n=181)
Incomplete questionnaire (n=22)
Quit this study (n=30)
917 women in the second follow-up
Drop-out reasons:
Busy with baby (n=120)
Incomplete questionnaire (n=20)
Quit this study (n=10)
970 women in the third follow-up
Drop-out reasons:
Busy with baby (n=299)
Incomplete questionnaire (n=12)
Quit this study (n=18)
781 women in the fourth follow-up
Drop-out reasons:
Busy with baby (n=399)
Incomplete questionnaire (n=92)
Quit this study (n=38)
563 women in the fifth follow-up
Drop-out reasons:
Busy with baby (n=210)
Incomplete questionnaire (n=61)
Quit this study (n=4)
779 women in the sixth follow-up
Excluded:
Data with only 1~2 follow-ups
(n=120)
1030 data in the final analysis

Figure 3

Two-class model of perinatal fatigue trajectory among women.

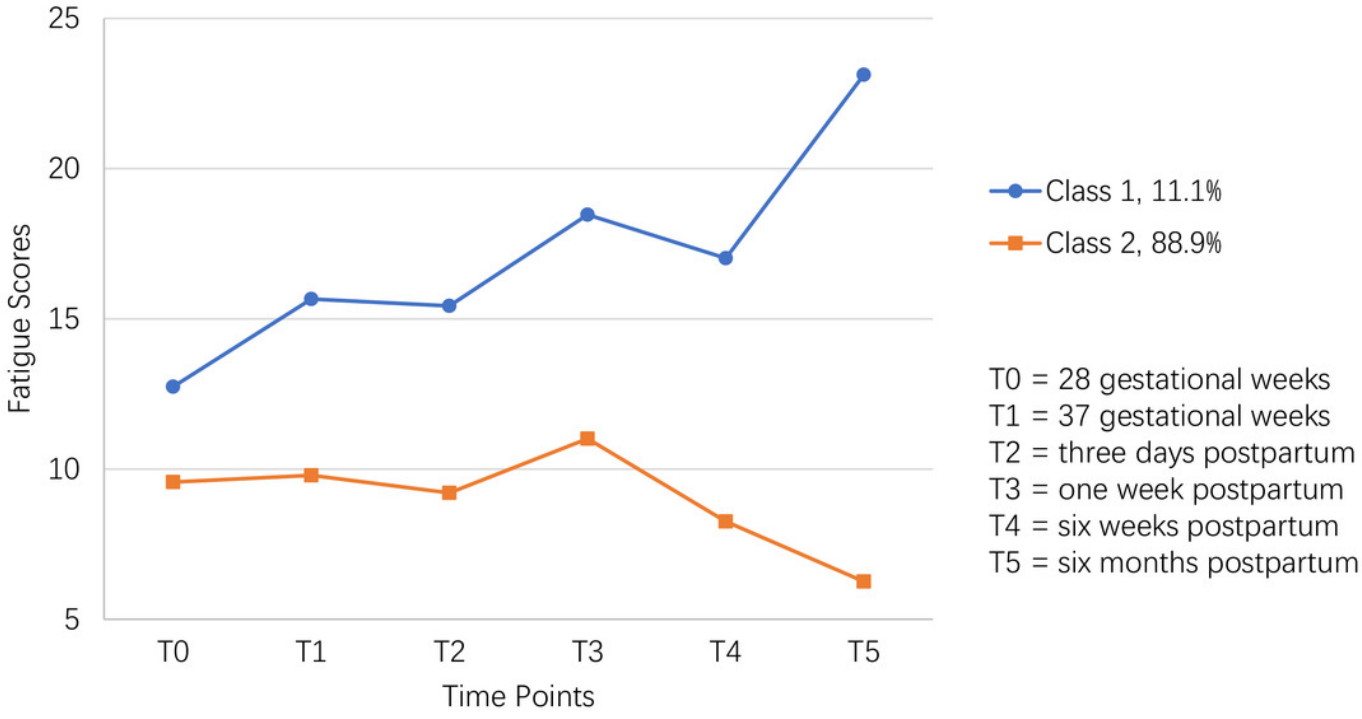

Table 1(on next page)

Fit indices for one to five fatigue trajectory classes of GMM.

Table 1 Fit indices for one to five fatigue trajectory classes of GMM.

C	k	AIC	BIC	aBIC	E	P of LMR	P of BLRT	class probability
1	11	33257.23	33311.54	33276.61	—	——	——	1
2	14	33022.68	33091.80	33047.33	**.865**	**.000**	**.0000**	**.908/.092**
3	17	32989.33	33073.26	33019.27	.821	.459	.0000	.850/.096/.053
4	20	32964.37	33063.11	32999.59	.831	.050	.0000	.830/.101/.057/.012
5	23	32951.67	33065.23	32992.18	.798	.360	.0000	.772/.109/.097/.012/.011

Footnotes. C = number of classes; k = number of free parameters; LL = loglikelihood; AIC = Akaike Information Criterion; BIC=Bayesian Information Criterion, aBIC = sample size adjusted BIC; E= Entropy; LMR = Lo-Mendell-Rubin test; BLRT = Bootstrap Likelihood Ratio Test; class probability=proportion of sample classification.

Table 2(on next page)

Fatigue scores at six times and during five adjacent times.

Table 2 Fatigue scores at six times and during five adjacent times.

Variables	Persistently High (m, SD, M)	Persistently Low (m, SD, M)	U	Z	p
Fatigue at T_0	12.74(6.312), 12.00	9.57(5.455), 9.00	55314.500	4.937	**<0.001**
Fatigue at T_1	15.66(9.53), 15.50	9.79(7.373), 8.00	46577.500	5.399	**<0.001**
Fatigue at T_2	15.43(7.894), 14.00	9.2(6.813), 7.00	59067.000	7.509	**<0.001**
Fatigue at T_3	18.47(9.336), 18.00	11.01(7.483), 10.00	38128.500	6.703	**<0.001**
Fatigue at T_4	17.02(10.846), 18.00	8.26(6.323), 6.00	23391.500	6.071	**<0.001**
Fatigue at T_5	23.12(4.518), 22.00	6.26(3.993), 6.00	52148.000	14.188	**<0.001**
T_1-T_0 Fatigue	3.28(8.864), 2.00	0.38(7.602), 0.00	38087.500	2.651	**0.008**
T_2-T_1 Fatigue	0.05(11.23), -1.00	-0.73(7.713), 0.00	33258.000	0.131	0.896
T_3-T_2 Fatigue	2.86(11.28), 3.00	1.62(8.839), 1.00	23955.000	0.778	0.436
T_4-T_3 Fatigue	-0.83(14.432), 0.00	-3.06(8.791), -4.00	16427.500	0.456	0.648
T_5-T_4 Fatigue	9.62(10.012), 11.00	-2.1(6.504), -1.00	12552.500	6.947	**<0.001**

Footnotes. Mann-Whitney U test. m=mean, SD=standard deviation, M=median, T_0 =28 gestational weeks, T_1 =37 gestational weeks, T_2 =three days postpartum, T_3 =one week postpartum, T_4 =six weeks postpartum, T_5 =six months postpartum. T_1-T_0 Fatigue=fatigue at T_1 minus that at T_0. (T_2-T_1)/(T_3-T_2)/(T_4-T_3)/(T_5-T_4) Fatigue were named in similar way.

Table 3(on next page)

Descriptive statistics of factors between the trajectory classes.

Table 3 Descriptive statistics of factors between the trajectory classes.

Variables	Persistently High	Persistently Low	U	Z	p
Number of participant, n(%)	95(9.2)	935(90.8)	-	-	-
Situational Factors					
Age, m(SD), M, y	30.21(3.57), 30	30.45(3.66), 30	40745.5	-0.959	0.337
Parity, n(%)			42199.0	-1.013	0.311
Primipara	76(80.0)	702(75.1)			
Multipara	19(20.0)	230(24.6)			
Missing	0(0.0)	3(0.3)			
Employment, n(%)			46473.0	3.049	**0.002**
Employed	62(65.3)	749(80.1)			
Unemployed	28(29.5)	163(17.4)			
Missing	5(5.2)	23(2.5)			
Education Level, n(%)			44252.0	0.506	0.613
<college	7(7.4)	73(7.8)			
college	16(16.8)	175(18.7)			
>college	71(74.7)	671(71.8)			
Missing	1(1.1)	16(1.7)			
Monthly family Income, n(%)			40010.5	-0.489	0.625
<￥10,000	12(12.6)	118(12.6)			
￥10,000~20,000	47(49.5)	455(48.7)			
>￥20,000	31(32.6)	342(36.6)			
Missing	5(5.3)	20(2.1)			
Residency, n(%)			41431.5	-1.824	0.068
Urban	93(97.9)	891(95.3)			
Suburban	0(0)	32(3.4)			
Missing	2(2.1)	12(1.3)			
Planned Pregnancy, n(%)			39788.5	-1.543	0.123
Yes	59(62.1)	646(69.1)			
No	35(36.8)	271(29.0)			
Missing	1(1.1)	18(1.9)			
Prenatal Training, n(%)			39422.0	-1.451	0.147
Yes	17(17.9)	233(24.9)			
No	75(78.9)	687(73.5)			
Missing	3(3.2)	15(1.6)			
Sleep Duration, n(%), hours			44526.0	1.898	0.058
<six	9(9.5)	97(10.4)			
Six to eight	53(55.8)	651(69.6)			
>eight	26(27.4)	173(18.5)			
Missing	7(7.4)	14(1.5)			
Sleep quality, m(SD),M	7.00(1.10), 7	7.48(1.19), 8	31530.5	-4.252	**<0.001**
Fetus Gender, n(%)			37380.5	1.222	0.222
Boys	39(41.1)	425(45.5)			
Girls	47(49.5)	388(41.5)			
Missing	9(9.5)	122(13.0)			
Physiologic Factors					
Height, m(SD), M, cm	161.99(4.79),1.62	162.76(4.93),1.63	39954.5	-1.332	0.183
Prenatal Weight, m(SD), M	53.71(7.97),52.00	55.78(8.24),55.00	35223.0	-2.456	**0.014**
Prenatal BMI, m(SD), M	20.44(2.64),20.19	21.04(2.83),20.70	36474.5	-1.967	0.050
Weight at T_0, m(SD), M	62.89(8.22),61.00	65.20(8.66),65.00	35899.0	-2.487	**0.013**

BMI at T_0, m(SD), M	23.93(2.66), 23.63	24.59(2.96), 24.43	36905.0	-2.094	**0.036**
Weight Gain at T_0, m(SD), M	9.05(2.83), 9.00	9.43(3.48), 9.05	38264.5	-1.132	0.258
BMI Gain at T_0, m(SD), M	3.45(1.06), 3.61	3.56(1.31), 3.54	38957.0	-0.849	0.396
Gestation, m(SD), M	29.07(0.70), 29.14	29.18(0.74), 29.14	40055.5	-0.882	0.378
Complication, n(%)			28058.5	-3.877	**<0.001**
YES	27(28.4)	139(14.9)			
NO	53(55.8)	710(75.9)			
Missing	15(15.8)	86(9.2)			
Pain, m(SD), M	2.54(2.70),1.50	2.03(2.28), 2.00	36871.0	1.264	0.206
Fatigue at T_0, m(SD), M	12.74(6.312),12.00	9.57(5.455),9.00	55314.5	4.937	**<0.001**
Psychologic Factor					
Anxiety, n(%)			46235.0	5.419	**<0.001**
One to three	12(12.6)	243(26.0)			
Four to six	12(12.6)	230(24.6)			
Seven to nine	17(17.9)	194(20.7)			
Ten	41(43.2)	168(18.0)			
Missing	13(13.7)	100(10.7)			
Maternal Outcomes					
Difficult Baby Care, n(%)			32522.0	4.706	**<0.001**
YES	35(36.8)	158(16.9)			
NO	39(41.1)	546(58.4)			
Missing	21(22.1)	231(24.7)			
Exclusive Breastfeeding, n(%)			20217.5	-3.102	**0.002**
YES	31(32.6)	439(47.0)			
NO	40(42.1)	263(28.1)			
Missing	24(25.3)	233(24.9)			
Weight at T_5 , m(SD), M	57.48(7.95), 56.50	56.98(8.34), 55.00	26815.5	0.844	0.399
Weight Retention at T_5, n(%)			18802.5	-3.281	**0.001**
YES	55(57.9)	380(42.0)			
NO	15(15.8)	293(30.0)			
Missing	25(26.3)	262(28.0)			

Footnotes. Mann-Whitney U test. m=mean, SD=standard deviation, M=median, n=number, %=percentage, y=year(s), cm=centimeters(s), h=hour(s), BMI=body mass index, T_0=28 gestational weeks, T_1=37 gestational weeks, T_5=six months postpartum.

Table 4(on next page)

Binary Logistic Regression for Class Membership.

Table 4 Binary Logistic Regression for Class Membership.

Variable	B	SE	W	df	P	OR	95%CI OR
Complication	1.022	0.269	14.453	1	<0.001	2.779	1.641~4.706
Fatigue at T_0	0.083	0.021	15.553	1	<0.001	1.086	1.042~1.132
Employment	-0.609	0.287	4.508	1	0.034	0.544	0.310~0.954
constant	-3.101	0.356	75.992	1	<0.001	0.045	-

Footnotes. Binary Logistic Regression. B=regression coefficient, SE=standard error; W=ward, df=degree of freedom; OR=odd ratio; CI=confidence interval.