The prevalence of orthostatic dysregulation among newly graduated female nurses after employment and its associations with autonomic nervous function, stress, and depressive symptoms

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Abstract

Objectives: We aimed to examine the prevalence of orthostatic dysregulation among newly graduated female nurses after employment and its associations with autonomic nervous function, stress, and depressive symptoms.

Methods: This follow-up study included 48 newly graduated female nurses (aged 22 ± 3 years) employed in acute care hospitals. The orthostatic dysregulation symptoms were evaluated using a screening checklist. A sit-to-stand test was conducted to assess the autonomic nervous function. Subjective stress and depressive symptoms were determined using a self-administered questionnaire. The data were collected at baseline on the first month and on the seventh month of employment. Statistical differences within groups were analyzed using paired t-test and McNemar’s test. The independent associations of orthostatic dysregulation status with stress and depressive symptoms were analyzed using a multivariate logistic regression model.

Results: The percentage of individuals who were diagnosed with orthostatic dysregulation increased from 25.0% at baseline to 35.4% at follow-up. Logistic regression analyses revealed that stress and depressive symptoms were closely associated with orthostatic dysregulation status at follow-up, despite a weak association reported at baseline. The participants were categorized according to their orthostatic dysregulation status: among individuals without orthostatic dysregulation at baseline but with orthostatic dysregulation at follow-up, the increase in autonomic nervous activity, as assessed by the coefficient of variation of the R-R intervals, in response to the postural changes was significantly attenuated at follow-up. Furthermore, this group exhibited a significant increase in stress and depressive symptoms.

Conclusions: At 7 months after employment, newly graduated nurses showed a higher prevalence of orthostatic dysregulation in combination with autonomic nervous system modulation, which was accompanied by an increase in stress and depressive symptoms. These observations suggest that the orthostatic dysregulation is associated with poor mental and physical health among newly graduated nurses in the early phase of employment.

Keywords

Newly graduated nurse, orthostatic dysregulation, autonomic nervous function, stress, depressive symptoms

Introduction

Orthostatic dysregulation (OD), characterized by autonomic nervous system dysfunction, occurs secondary to the inability of the body to compensate for hemodynamic changes associated with standing up.¹ OD is associated with various symptoms including vertigo, loss of consciousness, difficulty waking up, fatigability, heart palpitations, and headache. Some patients with OD also show circadian rhythm abnormalities and sleep disorders.¹,² OD is common during puberty, and symptoms tend to improve with age.³ However, OD may persist into adulthood or recur secondary to environmental stressors, such as admission and employment.²,⁴,⁵ This tendency is more commonly observed in women;

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Therefore, the prevalence of OD symptoms is higher in women, even in adulthood.6,7 Nurses at acute care hospitals are required to have the skills necessary to handle severe acute stage symptoms.8 Newly graduated nurses in such hospitals are exposed to various environmental stressors owing to learning nursing techniques, managing interpersonal relationships at work, dealing with patients and their families, and experiencing sudden changes in patients’ condition and their deaths.9,10 Thus, newly graduated nurses are prone to developing mental and physical symptoms such as chronic fatigue, weakness, listlessness, anxiety, and depression, thus leading to premature resignations.11–14 The OD is associated with vulnerability to worsening mental and physical health conditions.2 In addition, patients with OD often experience symptoms in the morning.1,4 Therefore, they are more likely to take a time off from work, interfering with their day-to-day duties. If this situation continues, they may experience burnout or prematurely resign from their job. Thus, the OD may affect the productivity of newly graduated nurses and is therefore a serious health concern. However, no studies have investigated the effect of OD on mental and physical health in newly graduated nurses.

Therefore, this study aimed to investigate the prevalence of OD in newly graduated female nurses at 1 and 7 months after employment and to evaluate the relationship between OD and autonomic nervous function, stress, and depressive symptoms.

Methods

Study participants

This longitudinal observational study included nurses employed at two acute care hospitals with more than 800 hospital beds in Wakayama Prefecture in western Japan. This study was performed in April 2014; 118 nurses were employed on a full-time basis at the hospitals at this time and of these, 105 newly graduated female nurses without any previous work experience at another hospital were enrolled in the study. Following were the inclusion criteria for this study: (1) age < 30 years; (2) no history of treatment for dizziness, anemia, psychological disorders, autonomic ataxia, intractable neurological diseases, or endocrine diseases; and (3) no echocardiographic evidence of coronary heart disease or cardiac arrhythmia. Although 98 newly graduated nurses were eligible, five did not provide written consent. Therefore, only 93 nurses could be included in this study. A baseline survey was performed 1 month after employment; 38 of the 93 eligible nurses did not respond to the follow-up survey performed 7 months after employment. Of the 55 participants who completed the baseline and follow-up surveys, we excluded seven who had incomplete data concerning outcome measures or those in whom baseline and follow-up survey data could not be linked. Eventually, 48 newly graduated nurses were included in the study.

The study protocol was reviewed and approved by the ethics committee of Wakayama Medical University (approval no. 1324). Written informed consent was obtained from all participants before study inclusion. Participants were briefed on the purpose and background of the study, the experimental procedures, and confidentiality issues. They were also informed regarding the lack of any direct benefit from completing the study protocol and that the decision to participate in this study was voluntary and would not affect their association with the hospital. In addition, they could withdraw their consent and discontinue study participation at any time without prejudice.

General procedure

A questionnaire survey on OD, subjective stress, and depressive symptoms and a simple sit-to-stand (STS) test for evaluating autonomic nervous function were conducted 1 month after employment (April 2014) and 7 months after employment (November 2014). The follow-up survey was administered at a time when newly graduated nurses were likely to complain of mental and physical disorders, as reported in previous studies.14,15 The baseline and follow-up surveys were performed excluding 2 days after the participants worked in the night shift as well as several weeks before and during menstruation to the extent possible. The participants were instructed to refrain from performing vigorous physical activity the day before the test as well as to avoid taking medications, eating breakfast, smoking, and drinking beverages containing caffeine for at least 3 h before the test.

OD

OD-related symptoms were evaluated using the screening checklist for OD recommended by the Task Force of Clinical Guidelines for Child Orthostatic Dysregulation, Japanese Society of Psychosomatic Pediatrics (supplementary Table 1).16 The checklist consisted of questions related to the five major OD-related manifestations (vertigo and dizziness on standing, fainting in the standing position, nausea, palpitations and/or dyspnea, and difficulty in getting out of bed) and six minor OD-related manifestations (pallor, anorexia, occasional umbilical colic, fatigability, frequent headache, and motion sickness). Each item on the checklist was rated using a 4-point scale (frequently, sometimes, occasionally, or never). In accordance with the diagnostic criteria,17 an individual was considered OD positive if she had “three or more major manifestations,” “two major manifestations + one or more minor manifestations,” or “one major manifestation + three or more minor manifestations.” Furthermore, the participants were considered to have a positive OD if they did not have any disease that could induce OD including iron-deficient anemia, heart disease, neurological diseases, or adrenal and thyroid endocrine abnormalities. We obtained permission from the Japanese Society of Psychosomatic Pediatrics to use the OD screening checklist.
Autonomic nervous function

After at least 5 min of rest in a quiet room with a temperature of approximately 25°C, the participants underwent a simple STS test, which involve sitting for 2 min, followed by standing for 2 min, and then sitting for 1 min.18 During the test, the RR interval of the electrocardiogram was continuously recorded by attaching the electrodes of a heart rate monitor to the wrists and chest of the participants for autonomic nerve analysis (LRR-03; Crosswell Co., Ltd, Kanagawa, Japan). The heart rate data were subjected to chronological analysis and frequency analysis using a heart rate variability (HRV) analyzer (Meijin, Crosswell Co., Ltd, Kanagawa, Japan).19 The overall autonomic nervous activity was assessed while the participant was in standing position using the coefficient of variation of the RR interval of the electrocardiogram (CVR-R).20

Stress

Stress was evaluated using the Japanese version of the Impact of Event Scale-Revised (IES-R), which is a 22-item self-report measure that assesses subjective distress caused by traumatic events (supplementary Table 2).21 The IES-R contains three subscales, which reflect intrusion, avoidance, and hyperarousal symptoms. The participants were asked to identify the different stressful events that they experienced during their hospital duties and then indicate how much they were distressed or bothered during the past week. The items on the questionnaire were rated on a 5-point scale ranging from 0 (not at all) to 4 (extremely); the total score and subscale scores were calculated. The total score ranged from 0 to 80, with higher scores indicating greater levels of stress. A score of ≥25 indicated a risk of posttraumatic stress disorder.22 The permission to use the IES-R in this study was obtained from the Japanese Society for Traumatic Stress Studies.

Depressive symptom

The Center for Epidemiological Studies Depression Scale (CES-D) was used to assess the state of depression with the permission of the copyright publisher (supplementary Table 3).23 The scale was developed to measure the severity of depressive symptoms in the general population. It comprises 20 items that screen various symptoms of depression and has a 4-factor structure representing somatic complaints, depressed affect, absence of positive affect, and interpersonal challenges. The intensity and frequency of each symptom were rated by the participants using a 4-point scale ranging from 0 (rarely or none of the time (<1 d) to 3 (most or all of the time (5–7 d)), with possible scores ranging from 0 to 60. Higher scores indicated increasing levels of depression, while scores ≥16 were suggestive of significant levels of depressive symptoms.24 We obtained a permission agreement from a copyright publisher to use the CES-D for this study.

Demographic and lifestyle variables

A simple self-administered questionnaire created for this study was used to collect data on age, height, weight, night shift work (yes/no), bedtime and wake-up time, sleep duration, alcohol drinking (yes/no), cigarette smoking (yes/no), and breakfast (almost every day, sometimes, or infrequently; Supplementary Table 4).

Statistical analysis

The differences in OD symptoms, HRV parameters during a STS test, and subjective stress and depressive symptoms between baseline and follow-up were evaluated. The study participants were categorized into subgroups based on the OD status (negative/positive) from baseline to follow-up: negative to negative (n = 28), negative to positive (n = 8), positive to positive (n = 9), and positive to negative (n = 3). The changes in level of subjective stress and depressive symptoms were examined within each of these subgroups except for the positive to negative group. Statistical differences in mean values within groups were analyzed using paired t-test, whereas differences in frequency were assessed using McNemar’s test. The differences in mean values between groups were evaluated using Student’s t-test or Welch’s t-test for unpaired values.

The independent associations of OD status with subjective stress and depressive symptoms were analyzed using a multivariate logistic regression model with propensity score adjustment. The predicted probability of an OD was calculated by fitting a logistic regression model using relevant variables including age, body mass index (BMI; ≥18.5 kg/m²), bedtime (<12:00 a.m.), sleep duration (6–6.9 h), and working in the night shift (no). The odds ratios (ORs) and 95% confidence intervals (CIs) were calculated with one standard deviation increment for each dependent variable.

All statistical analyses were conducted using IBM SPSS Statistics for Windows (version 22; IBM Corp., Armonk, NY, USA). The null hypothesis was rejected at a significance level of p < 0.05.

Results

At the follow-up survey, 90% of the participants were initially assigned in the night shift (Table 1). The wake-up time was slightly later, total sleeping duration tended to be longer, and skipping breakfast was significantly increased compared with baseline.

The number of individuals diagnosed as OD positive increased from 12 (25.0%) at baseline to 17 (35.4%) at follow-up (Table 2). Among the major OD-related symptoms, vertigo and dizziness during standing were observed frequently at
both baseline and follow-up. The prevalence of pallor and fatigability significantly increased from baseline to follow-up ($p < 0.05$). The total number of minor symptoms significantly increased at follow-up relative to baseline ($p < 0.01$).

The HRV parameters measured during the STS test are shown in Table 3. No difference was observed in the CV $R-R$ values when the participants were in sitting position. However, the CV $R-R$ values after standing up decreased at follow-up relative to the baseline ($p < 0.05$). A significant difference was also found in the change in CV $R-R$ values from sitting to standing ($p < 0.05$). The IES-R stress scale showed a significant increase in the scores for hyperarousal at follow-up. The CES-D total scores tended to increase at follow-up, but were not significantly different from the baseline values. The proportion of individuals with high levels of stress and depressive symptoms at follow-up was approximately 1.5 times higher than that at baseline.

The HRV parameters measured during a STS test were compared between groups divided according to the status of OD (Figure 1). No clear differences were observed in the CV $R-R$ values between individuals with OD and those without OD at baseline. At follow-up, the individuals with OD had significantly lower CV $R-R$ values in standing position and showed a lesser change in CV $R-R$ values when standing up compared with that measured in the sitting position.

Multiple logistic regression analysis revealed that IES-R subscale scores representing intrusion and hyperarousal symptoms were significantly related to OD status at follow-up after adjusting for possible confounding factors, although these associations were weak at baseline (Table 4). In addition, a significant association between OD status and CES-D subscales was found only in somatic complaints at baseline; at the follow-up, depressed affect was found to be more strongly related to OD than to somatic complaints.

### Table 1. Demographic characteristics and daily living habit among study participants at the baseline and follow-up surveys ($n=48$).

| Variables                        | Baseline (1 month after employment) | Follow-up (7 months after employment) | $p^a$ |
|----------------------------------|-------------------------------------|---------------------------------------|-------|
|                                  | $n$ (%)                             | $n$ (%)                               |       |
| Body mass index, kg/m$^2$         |                                    |                                       | 0.607 |
| $<18.5$                          | 33 (68.8)                           | 36 (75.0)                             |       |
| 18.5–24.9                        | 12 (25.0)                           | 10 (20.8)                             |       |
| $\geq 25.0$                      | 3 (6.3)                             | 2 (4.2)                               |       |
| Working in the night shift       |                                    |                                       | <0.001|
| Yes                              | 0 (0)                               | 44 (91.7)                             |       |
| No                               | 48 (100)                            | 4 (8.3)                               |       |
| Bedtime                          |                                    |                                       | 0.856 |
| $<12:00$ a.m.                    | 18 (37.5)                           | 19 (39.6)                             |       |
| 12:00 a.m.–12:59 a.m.            | 25 (52.1)                           | 23 (47.9)                             |       |
| $\geq 1:00$ a.m.                 | 5 (10.4)                            | 6 (12.5)                              |       |
| Wake-up time                     |                                    |                                       | 0.151 |
| $<6:00$ a.m.                     | 2 (4.2)                             | 1 (2.1)                               |       |
| 6:00 a.m.–6:59 a.m.              | 39 (81.3)                           | 35 (72.9)                             |       |
| $\geq 7:00$ a.m.                 | 7 (14.6)                            | 12 (25.0)                             |       |
| Sleep duration, h                |                                    |                                       | 0.206 |
| $<6$                             | 2 (4.2)                             | 1 (2.1)                               |       |
| 6–6.9                            | 39 (81.3)                           | 35 (72.9)                             |       |
| $\geq 7$                         | 7 (14.6)                            | 12 (25.0)                             |       |
| Alcohol drinking                 |                                    |                                       | 0.508 |
| Yes                              | 15 (31.2)                           | 18 (37.5)                             |       |
| No                               | 33 (68.8)                           | 30 (62.5)                             |       |
| Cigarette smoking                |                                    |                                       | –     |
| Yes                              | 0 (0)                               | 1 (2.1)                               |       |
| No                               | 48 (100)                            | 47 (97.9)                             |       |
| Breakfast                        |                                    |                                       | 0.012 |
| Almost everyday                  | 43 (89.6)                           | 28 (58.3)                             |       |
| Sometimes                        | 2 (4.2)                             | 3 (6.3)                               |       |
| Rarely                           | 3 (6.2)                             | 17 (35.4)                             |       |

$^a$The $p$ values indicate significant difference by McNemar’s test.
Based on the changes in OD status from baseline to follow-up (negative/positive), participants were categorized into three groups, and the IES-R and CES-D subscale scores at baseline and follow-up were compared in each group of participants (Figure 2). In the negative to negative group, no clear difference was found in any of the IES-R subscale scores between baseline and follow-up. In the negative to positive group, the IES-R subscales showed significantly higher scores at follow-up than at baseline. Furthermore, CES-D subscale scores relevant to somatic complaints and depressed affect in the negative to positive group were significantly increased at follow-up compared with those at baseline. The subscale scores of the positive to positive group were not significantly different between baseline and follow-up, but their scores were consistently higher than those of the other groups.

**Discussion**

In this study, we conducted a follow-up survey from 1 to 7 months after employment in newly graduated female nurses employed in acute care hospitals. At follow-up, the number of individuals diagnosed as OD positive increased compared with that at baseline. The IES-R and CES-D subscale scores were closely associated with the OD status at follow-up, despite their weak associations at baseline. Among subgroups whose OD status changed from negative to positive, the increase in CVR-R values upon standing up was significantly attenuated at follow-up. Furthermore, this group exhibited a significant increase in the IES-R and CES-D subscale scores. These observations indicate that worsening of OD symptoms and autonomic nervous system dysfunction may occur in newly graduated nurses in the early phase of employment and are accompanied by an increase in stress and depressive symptoms.

Among the study participants, 25.0% were diagnosed as OD positive based on the checklist at baseline, while 35.4% were diagnosed as OD positive at follow-up. Although OD commonly occurs during puberty, it is not unusual for OD to persist into adulthood or recur due to lifestyle changes, including dietary behaviors and sleeping patterns, after advancement in education or employment. The prevalence of OD
increased by approximately 10% from baseline to follow-up. Extreme psychosocial stress exacerbates the OD-related symptoms. Newly graduated nurses may experience high levels of environmental stressors owing to learning nursing techniques, managing interpersonal relationships at work, dealing with patients and their families, and experiencing sudden changes in patients’ condition and deaths. Furthermore, as they begin to work in the night shift approximately 6 months after employment, it is likely that their circadian rhythm is disrupted. These factors may be associated with an increased prevalence of OD after 7 months in the study participants.

In addition to the interview conducted using the checklist for screening OD, a STS test was performed to evaluate for autonomic nervous system modulation, which is considered the major cause of OD symptom deteriorations. Compared with the value at baseline, a significant decrease was observed in the CVR-R values after standing up and the change relative to the sitting position at follow-up. Vertigo and dizziness, which are the major symptoms of OD, are both related to a delayed autonomic nervous response to standing up and a delayed switch in the parasympathetic nervous system activity and the sympathetic nervous system activity. Although we only assessed the overall autonomic nervous activity based on the changes in CVR-R, individuals with OD exhibited significantly lower CVR-R at standing position and a lower change relative to the seated position than those without OD at the follow-up. In addition, individuals whose OD status changed from negative to positive (negative to positive group) showed a significant decline in CVR-R after standing up. These observations may support the idea that OD symptoms worsen in association with irregularities in the autonomic nervous system.

Based on the assessment of subjective stress using the IES-R, 18.8% of the individuals had high stress levels at baseline. This prevalence is similar to those reported in previous studies, showing that 21.3% of nurses in the psychiatric departments and 18.8% of nurses in the emergency medicine department had high stress levels. Furthermore, as they begin to work in the night shift approximately 6 months after employment, it is likely that their circadian rhythm is disrupted. These factors may be associated with an increased prevalence of OD after 7 months in the study participants.

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The IES-R subscales of intrusion and hyperarousal symptoms were significantly related to OD status diagnosed at the follow-up survey, although these associations were not observed at baseline. In addition, the negative to positive group had higher scores on all subscales, including avoidance symptoms at follow-up. These observations suggest that the stressors associated with a variety of events experienced during nursing duties may have contributed to the increase in the severity of OD symptoms. Furthermore, the positive to positive group had higher scores for intrusion and

### Table 3. Stress and depressive symptoms among study participants at the baseline and follow-up surveys.

| Variables                      | Baseline (1 month after employment) | Follow-up (7 months after employment) | p* |
|--------------------------------|-------------------------------------|---------------------------------------|----|
| HRV, %                         |                                     |                                       |    |
| CVR-R rest                     | 4.78 (4.41–5.15)                    | 4.74 (4.36–5.10)                      | 0.838 |
| CVR-R standing                 | 7.2 (6.62–7.71)                     | 6.57 (6.13–7.02)                      | 0.031 |
| ΔCVR-R                         | 2.42 (1.89–2.95)                    | 1.83 (1.38–2.33)                      | 0.044 |
| IES-R (stress)                 |                                     |                                       |    |
| Intrusion                      | 7.1 (5.4–8.9)                       | 8 (6.3–9.7)                           | 0.203 |
| Avoidance                      | 6 (4.4–7.7)                         | 6.3 (4.8–7.8)                         | 0.727 |
| Hyperarousal                   | 3.9 (2.8–4.9)                       | 4.9 (3.8–6.1)                         | 0.043 |
| Total score                    | 17.2 (13.2–20.9)                    | 19.2 (13.1–23.1)                      | 0.137 |
| ⩾25 points                     | 9 (18.8)                            | 14 (29.2)                             | 0.180 |
| CES-D (depressive symptoms)   |                                     |                                       |    |
| Somatic complaints             | 3.2 (2.2–4.1)                       | 3.8 (3.0–4.6)                         | 0.079 |
| Depressed affect               | 3.1 (2.2–3.9)                       | 3.8 (2.8–4.7)                         | 0.110 |
| Absence of positive affect     | 6.8 (6.1–7.6)                       | 6.8 (6.0–7.5)                         | 0.868 |
| Interpersonal challenges       | 0.8 (0.4–1.1)                       | 1 (0.7–1.4)                           | 0.140 |
| Total score                    | 13.8 (11.4–16.2)                    | 15.4 (13.1–17.7)                      | 0.098 |
| ⩾16 points                     | 12 (25.0)                           | 19 (39.6)                             | 0.180 |

M: mean; CI: confidence interval; HRV: heart rate variability; and CVR-R: coefficient of variation of R-R intervals on electrocardiogram; IES-R: Impact of Event Scale-Revised; CES-D: Center for Epidemiologic Studies Depression Scale.

*p values indicate significant difference by paired t-test and McNemar’s test.
hyperarousal symptoms at baseline than the other groups, and the scores further increased at follow-up. Therefore, stress symptoms are more likely to be exacerbated in the presence of OD.\(^2\)

Of the total study participants, 25.0% of them were in a depressed state at baseline, while 39.6% were in depressed state at follow-up. Numerous studies have reported a high prevalence of depression among nurses employed in hospitals. Studies that utilized the CES-D found that 54.0% of nurses working at acute care hospitals\(^29\) and 46.4% of nurses working at pediatric hospitals\(^30\) were at risk of depression. Another study found that in newly graduated nurses, depressive mood and trait anxiety intensified 4 months after employment\(^31\) and burnout began to occur 6 months after employment.\(^13\)\(^\text{-}\)\(^15\)

In this study, the negative to positive group showed significantly higher scores for physical complaints and depressed affect at follow-up relative to baseline. Thus, worsening of OD status is accompanied by an increase in depressive symptoms. This observation is supported by the reports of a previous study, which indicated that the severity of depression has an inverse relationship with autonomic nervous system activity.\(^32\) In addition, a significant association with OD status was found only in nurses with somatic complaints at baseline; however, depressed affect was more strongly related to OD status than somatic complaints at follow-up. Therefore, physical factors such as lack of energy, poor appetite, and reduced attention are more related to OD status during the first few months of employment. However, at the seventh month of employment, OD status may have a stronger relationship with mental factors such as depressive mood and anxiety than with physical factors.

Several potential limitations should be considered. This study included a selective sample consisting of newly graduated nurses employed at large-sized acute care hospitals in a specific prefecture of Japan. Moreover, we focused only on female nurses based on findings of previous studies that report a higher frequency of OD during puberty and a greater likelihood of persistence of OD in adulthood in women.\(^6\)\(^,\)\(^7\) Therefore, the results of this study are not applicable to male nurses. Another limitation of our study is small number of samples, which shows small power of the study. About half of the participants did not complete the follow-up survey mainly because their work schedules. As this study included an assessment of autonomic nervous function, the survey was conducted excluding 2 days after they worked in the night shift. However, it was difficult to set the day appropriate to perform the survey in the situation where most participants had begun working in the night shift. Thus, the samples used for analysis might not be representative of the population of interest. This potentially limits the ability to generalize the results of this study. As another caveat, small samples can result in an increased risk of errors in the statistical hypothesis testing. Hence, a multivariate regression analysis was performed using a propensity score adjustment method to reduce the risk of overfitting in the model; however, there may be a likelihood of exaggerated OR due to the small number of cases. Furthermore, we determined the OD status of individuals using a screening checklist recommended by the Japanese Society of Psychosomatic Pediatrics.\(^16\) This checklist was developed to screen patients with OD symptoms in clinical settings. To definitively diagnose OD, the OD subtypes must be determined based on the results of the continuous measurement of blood pressure and heart rate during the standing test.\(^17\) However, this checklist includes a wide range of symptoms associated with OD and has been reported to screen for OD with a satisfactory degree of

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**Figure 1.** Heart rate variability ($CV_{re}$) at the sitting and standing positions during sit-to-stand test according to orthostatic dysregulation status at the baseline and follow-up surveys. Number of participants with orthostatic dysregulation at baseline and follow-up was 12 and 17, respectively. Values are mean (95% confidence intervals). \(^*\)p < 0.05 by Student’s t-test or Welch’s t-test for unpaired values.
Table 4. Logistic regression analyses for the associations of orthostatic dysregulation with stress and depressive symptoms at the baseline and follow-up surveys.

| Variables                      | Baseline (1 month after employment) | Follow-up (7 months after employment) |
|-------------------------------|-------------------------------------|----------------------------------------|
|                               | OR a (95% CI)                       | OR a (95% CI)                          |
| IES-R (traumatic stress)      |                                     |                                        |
| Intrusion                     | 1.06 (0.56–2.11)                    | 2.51 (1.19–5.32)*                     |
| Avoidance                     | 0.52 (0.40–1.72)                    | 1.85 (0.95–3.60)                      |
| Hyperarousal                  | 1.70 (0.86–3.32)                    | 3.20 (1.37–7.70)**                    |
| CES-D (depressive symptoms)   |                                     |                                        |
| Somatic complaints            | 3.50 (1.36–8.91)**                  | 2.33 (1.14–4.82)*                     |
| Depressed affect              | 2.02 (0.98–4.11)                    | 3.14 (1.20–8.13)*                     |
| Absence of positive affect    | 1.46 (0.66–3.14)                    | 1.48 (0.78–2.79)                      |
| Interpersonal challenges      | 1.97 (0.99–3.99)                    | 1.53 (0.78–2.97)                      |

OR: odds ratio; CI: confidence interval; IES-R: Impact of Event Scale-Revised; CES-D: Center for Epidemiologic Studies Depression Scale.

*Adjusted with a propensity score. The predicted probability of an orthostatic dysregulation was calculated by fitting a logistic regression model using relevant variables including age, BMI (\(\geq 18.5\) kg/m\(^2\)), bedtime (\(< 12:00\) a.m.), sleep duration (6–6.9 h), and working in the night shift (no). Odds ratios were estimated per one standard deviation increment for each variable.

*\(p<0.05\), **\(p<0.01\).

Figure 2. Stress and depressive symptoms among subgroups according to the orthostatic dysregulation status at the baseline and follow-up surveys.

Values are mean (95% confidence intervals). N to N, the negative to negative group (N=28); N to P, the negative to positive group (N=8); P to P, the positive to positive group (N=9); IES-R, Impact of Event Scale—Revised; CES-D, Center for Epidemiologic Studies Depression Scale.

*\(p<0.05\), **\(p<0.01\) by paired t-test.
reliability. In addition, a self-administered questionnaire was used to collect data on medical history and daily habit for participants such as sleep, diet, and exercise. However, the validity and reliability of the questionnaire were not verified. Finally, we conducted a follow-up survey only once. Moreover, previous studies have indicated that newly graduated nurses show a higher tendency to develop mental and physical disorders after 4 months with burnout observed after 6 months. Based on the findings, the follow-up survey was performed seven months after employment. However, as newly graduated nurses undertake more duties, they may experience increased levels of physical and mental burdens. Therefore, further studies with longer follow-up are warranted to gain a deeper understanding of this subject.

Conclusion
This follow-up study demonstrated that newly graduated nurses showed a higher prevalence of OD in combination with autonomic nervous system modulation at 7 months after employment. Furthermore, OD is associated with higher risk of increased subjective stress and depressive symptoms. These observations indicate that the OD may be one of the causes of poor mental and physical health in newly graduated nurses in the early phase of employment. The results of this study may be helpful when considering useful support for health care and work adaptation.

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