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Latent Growth Mixture Modeling to Estimate Differential PTSD Trajectories and Associated Risk Factors in Psychiatric Staff Following Workplace Violence

Ask Elklit[1*], Sara Al Ali[1,2], Jesper Pihl-Thingvad[2]

[1]The National Center of Psychotraumatology, Department of Psychology, University of Southern Denmark, Odense, Denmark
[2]Department of Occupational and Environmental Medicine, Odense University Hospital, Odense, Denmark
Email: *aelklit@health.sdu.dk

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Abstract

Background: Workplace violence (WV) towards psychiatric staff has commonly been associated with Posttraumatic Stress Disorder (PTSD). However, prospective studies have shown that not all psychiatric staff who experience workplace violence experience post-traumatic stress. **Purpose:** We want to examine the longitudinal trajectories of PTSD in this population to identify possible subgroups that might be more at risk. Furthermore, we need to investigate whether certain risk factors of PTSD might identify membership in the subgroups. **Method:** In a sample of psychiatric staff from 18 psychiatric wards in Denmark who had reported an incident of WV, we used Latent Growth Mixture Modelling (LGMM) and further logistic regression analysis to investigate this. **Results:** We found three separate PTSD trajectories: a recovering, a delayed-onset, and a moderate-stable trajectory. Higher social support and negative cognitive appraisals about oneself, the world and self-blame predicted membership in the delayed-onset trajectory, while higher social support and lower accept coping predicted membership in the delayed-onset trajectory. **Conclusion:** Although most psychiatric staff go through a natural recovery, it is important to be aware of and identify staff members who might be struggling long-term. More focus on the factors that might predict these groups should be an important task for psychiatric departments to prevent posttraumatic symptomatology from work.

Keywords

Latent Growth Mixture Modeling, PTSD Trajectories, Psychiatric Staff, Workplace Violence

1. Introduction

Posttraumatic Stress Disorder (PTSD) has been found to be a common response to workplace violence (WV) towards health personnel such as psychiatric staff [1]. However, longitudinal research has found that most psychiatric staff who experience WV do not develop PTSD [2] [3] [4]. This finding makes it interesting to examine whether there are different subpopulations of staff that experience different trajectories of development and duration of posttraumatic symptomatology. Furthermore, it would be important to examine whether possible differences in the trajectories could be associated with certain risk factors. One way to do this is by using statistical models such as Latent Growth Mixture Models (LGMM) [5], which have often been used to assess PTSD longitudinally after a traumatic event [6] [7]. These models can assess individual changes or stability of symptoms over time as well as estimate unobserved (latent) trajectories and have become increasingly popular. In LGMM, it is hypothesized that several different latent classes exist, where each class represents a subpopulation that differs in the developmental process, or growth trajectory of symptoms [8].

There is reason to believe that varying PTSD trajectories exist, and these trajectories have varied in the literature. Research has commonly found four PTSD trajectories: chronic, delayed, recovering and resilient trajectories [7]. However, across studies, there have been substantial differences in both the number of and the shape of trajectories, as well as the number of people in the subpopulations assigned to each trajectory. There have been observations of everything from two trajectories [9] to seven trajectories [10] in trauma samples. Studies that have employed LGMM with regard to PTSD trajectories have though studied different populations, *i.e.*, rape victims [6] [11], injury survivors [12] [13], whiplash [14] [15], or deployed service members [7] [16]. However, no studies have been done on victims of WV. Since each of these populations can often be associated with different risk factors and factors related to the traumatic experience, there is a possibility that these differences could explain the different PTSD trajectories that have been observed when using LGMM. If this is true, any comparison of PTSD trajectories across studies will be influenced by the differential distribution of the risk factors that can exist among the respective trauma population.

Whether the varying trajectory groups within a population are a result of different characteristics within the subsamples remains to be further examined. However, LGMM uses growth parameters such as intercepts and slopes to show the existence of multiple trajectories across multiple measurement occasions. This allows researchers to extend their analysis to investigate which variables differentiate membership in trajectory groups [5]. Although many explanatory variables have been shown to be related to PTSD, some have yet to be investigated with regards to the longitudinal changes in PTSD. Acute stress disorder (ASD) and social support are few factors that have been found to be significantly related to PTSD in psychiatric staff following WV [4]. However, other variables

such as negative cognitive appraisals, coping strategies, and organizational support, have been found to be meaningful in the development of PTSD in other occupational trauma populations [17]. Other variables that have been highlighted as influencing the severity and course of PTSD in general should also be accounted for, such as gender and age [18].

A major shortcoming of most of the literature about WV is that it is cross-sectional. Since WV is related to a broad number of consequences for psychiatric staff [1], it is worth examining the possible different trajectories of PTSD within this group, as well as the possible risk factors of each trajectory. Thus, the current study had two main aims. First, to test whether there are different trajectory subgroups of PTSD across three measurement points in a population of psychiatric staff who had experienced WV. Based on the research literature, it was hypothesized that at least three separate trajectory groups would exist. The second aim was to determine whether membership within a particular trajectory group can be defined by a number of individual (ASD, social support, coping, cognitive appraisals) and organizational (leadership support, colleague support) explanatory variables. We hypothesized that the explanatory variables would help differentiate between different groups. For example, those high on ASD, negative cognitive appraisals and dysfunctional coping strategies would be expected to belong to a trajectory group characterized by a high intercept (high PTSD symptom levels), whereas those individuals reporting high perceived social, leadership and colleague support would be expected to belong to a trajectory group characterized by a low intercept (low PTSD symptom levels). Hopefully, the aims of the current study will benefit the practitioners working with victims of occupational trauma by highlighting those most at risk for developing prolonged and severe PTSD symptomatology. This will also be beneficial in violence prevention at the workplace.

2. Methods

Participants

Participants in this prospective study included 398 psychiatric staff who had all reported an incident of WV at a psychiatric ward in Region Southern Denmark. When an incident of WV first got registered at the workplace for possible compensation through the national schemes, the research group was informed, and all participants received the first questionnaire within a month after the registration. The ones who filled out the first questionnaire were then contacted again 3 months, 6 months and 12 months after the initial reporting with follow-up questionnaires.

Measures

PTSD trajectories were assessed by using data from T2, T3 and T4, which measured PTSD symptoms using the Danish Version of the Harvard Trauma Questionnaire (HTQ) [19] [20]. The Danish version of the HTQ has shown good reliability and validity [20] and identifies possible PTSD on 18 items in our

questionnaire. The answers were scored on a 4-point Likert scale (1 = *not at all* to 4 = *All the time*), and we used the total score of the HTQ, which ranged from 18 to 72.

All possible explanatory variables were assessed by using data from T1. Age and gender were assessed as questions about the characteristics of the trauma. ASD was assessed using a translated Danish version of the Acute Stress Disorder scale (ASDS) [21]. It consists of 19 items and was developed to identify symptoms of traumatic stress in the acute period after a traumatic event and predict the later onset of PTSD. For the current analysis, the total score on the ASDS was used.

Coping was assessed using a translated Danish version of the Brief COPE [22], which is an abbreviated version of the Coping Orientation to Problems Experienced Inventory (COPE). It was developed to assess a broad range of coping strategies and is one of the most validated measures of coping responses. It consists of 28 items divided into 14 subscales: acceptance, emotional support, humor, positive reframing, religion (emotion-focused coping strategies), active coping, instrumental support, planning (problem-focused coping strategies), behavioral disengagement, denial, self-distraction, self-blaming, substance use and venting (dysfunctional coping strategies) [22]. The 28 items measure 14 coping responses of 2 items each, which are measured on a Likert scale from 0 = *I have not been doing this at all*, to 3 = *I have been doing this a lot*. Subscale scores were calculated by adding the scores of the two items in the subscale together.

Cognitive appraisals were measured using a translated Danish version of The Posttraumatic Cognitions Inventory (PTCI) [23]. It was developed to assess posttraumatic cognitive appraisals, as well as their relationship to posttraumatic reactions such as PTSD. It consists of 33 items that represent three factors: 1) Negative cognitions about the Self (21 items on the "Self" subscale), 2) Self-blame (5 items on the "Blame" subscale), and 3) Negative cognitions of the World (7 items on the "World" subscale). The items are assessed on a 7-point Likert scale, ranging from 1 = *totally disagree* to 7 = *totally agree*. A score was calculated for each of the three subscales by adding each item in the subscale and then dividing this raw score by the number of items involved. This is done to allow for the different numbers of items in each subscale, and results in a mean subscale score. A total score for the PTCI was calculated by adding the raw scores on all three subscales together.

Social support and organizational support were also assessed at T1. Organizational support was assessed on three measurements of psychosocial work environment, taken from existing Psychosocial Risk Assessments from Psychiatry in Region Southern Denmark. Two of them measure leadership support (leadership management and care for safety) and one measures colleague support (work coherence). They included one question each and were assessed on a 7-point Likert scale (1 = *very bad* to 7 = very *good*).

Social support was assessed using the Crisis Support Scale (CSS) [24]. It consists of seven items, where the first five are related to positive social support, the sixth one is about feeling let down by others, and the last is about social support satisfaction. They are assessed on a 7-point Likert scale (1 = *never* to 7 = *always* on the first six items, and 1 = *very unsatisfied* to 7 = *very satisfied* on the last item). A total score is calculated by adding the scores on the first six items together.

Ethical considerations

The project was conducted in accordance with the Declaration of Helsinki and approved by the Danish Data Protection Agency (# 2014-41-2992).

Data analysis

In the first step of the analysis, LGMM was used. This was done to identify possible different trajectories of individual PTSD symptomatology. The subgroup trajectories are identified by the two latent variables of slope and intercept. LGMM groups individuals into different trajectories based on how similar they are in model parameters across the three different time points of PTSD measure.

We tested a series of linear models: with 1, 2, 3, 4 and 5 different trajectories, to determine which model was the best fit for data. All models were tested using age and gender as covariates. Since the first linear model was statistically significant, we chose a linear as opposed to a quadric explanation of data. The model fit is determined by several fit indices: the likelihood ratio chi-square, the Bayesian Information Criterion (BIC), the Akaike Information Criterion (AIC), the sample size adjusted BIC (ssaBIC), the Lo-Menell-Rubins Adjusted Likelihood Ratio Test (LRT) as well as its p-value, and the entropy value. General rules state that the lower the AIC, BIC and ssaBIC are the better the fit or data. Other rules include a statistically significant LRT, an entropy close to 1, no classes with less than 1%, and qualitative rather than quantitative differences in trajectories.

During the second stage of the analysis, we wanted to determine whether membership to the different trajectories could be predicted by several explanatory variables. Therefore, logistic regression was used, with class membership as a dependent variable. The predictor variables were scores on the ASDS, CSS, Brief COPE, PTCI and organizational support. All analyses were conducted using Mplus 8.5 software.

3. Results

LGMM

Fit statistics for the model comparisons are shown in Table 1. The three-class solution was considered the optimal solution. The Lo-Mendell-Rubin's was significant for the solution and the AIC, BIC and ssaBIC all decreased from model one through to model four. Even though model four could also be considered an optimal solution using the fit indices only, when examining the differences between trajectories, the differences seemed to be indicative of quantitative differences between two of the groups rather than qualitative. It seemed to break

down one group into two subgroups that follow a similar pattern. Thus, the model with the lowest value should be accepted. The entropy value also indicated that many in the sample were correctly classified into subgroups. The figures deciphering the different models' trajectories are shown in Figure 1.

Descriptive statistics about the different trajectories show that the three-class solution identified a recovering group (Group 1 - 84.3%), a delayed group (Group 2 - 2.4%) and a stable group (Group 3 - 13.4%). The likelihood of belonging to the right group was 96.6% for group 1, 92.8% for group 2 and 91.5% for group 3. The slopes (S) and intercepts (I) were significant for all the three groups. A full overview of the descriptive statistics for the subgroups can be found in Table 2.

Using group 1, the recovering group that had the lowest level of PTSD symptomatology as our reference group, logistic regression in part two of the analysis indicated that posttraumatic negative cognitive appraisals predicted membership in group 3, the stable group. This was the case for both negative cognitions about the world (OR = 1.01, $p < 0.05$), self-blame (OR = 2.48, $p < 0.05$) and negative

Table 1. Fit statistics for the five models.

Model	Loglikelihood	AIC	BIC	SSABIC	LRT	Entropy
1	−1771.727	3561.454	3589.885	3561.386	-	-
2	−1732.122	3488.244	3526.153	3488.153	74.402 ($p \leq 0.05$)	0.982
3	−1710.642	3451.285	3498.671	3451.171	40.352 ($p \leq 0.05$)	0.898
4	−1700.974	3437.948	3494.811	3437.811	18.164 ($p \leq 0.05$)	0.892
5	−1689.781	3424.722	3487.903	3421.403	21.027 ($p = 0.149$)	0.925

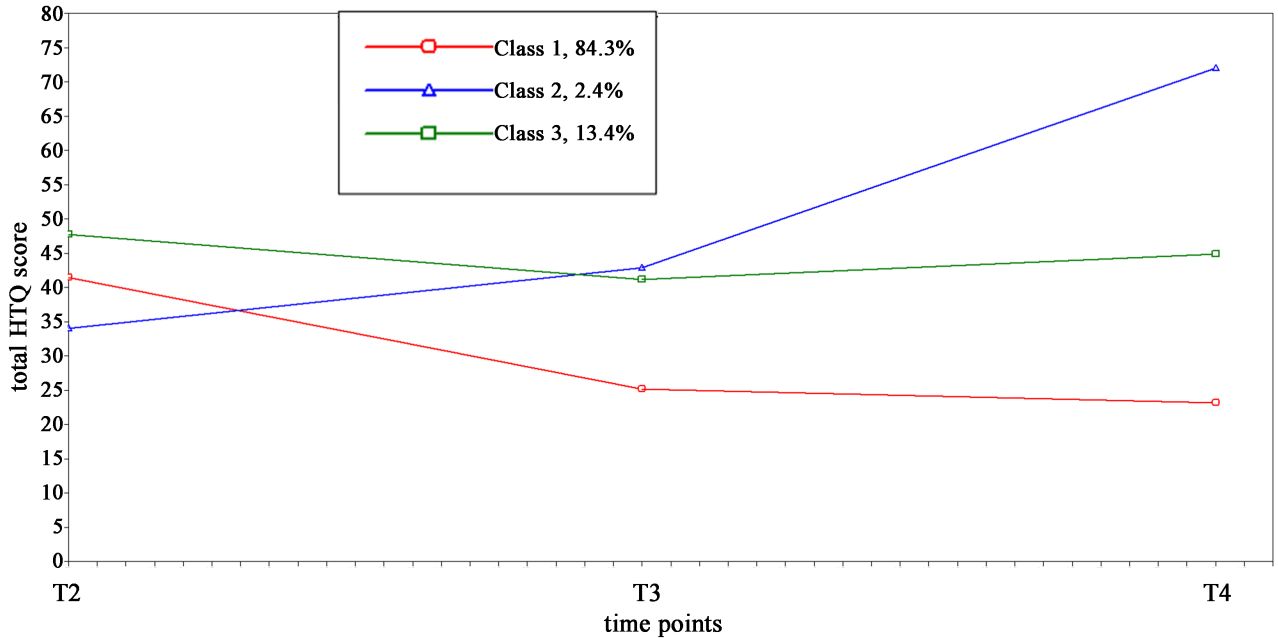

Figure 1. Graphs of the three model PTSD trajectory solution.

Table 2. Descriptive statistics for the three-class solution.

Latent class	Members (%)	Likelihood of belonging (%)	Intercept	Slope
1 (recovering)	84.3%	96.6%	31.332 ($p < 0.001$)	−11.399 ($p < 0.001$)
2 (delayed)	2.4%	92.8%	24.220 ($p < 0.01$	18.198 ($p < 0.001$)
3 (stable)	13.4%	91.5%	36.387 ($p < 0.001$)	−5.295 ($p < 0.05$)

cognitions about the self (OR = 2.11, $p < 0.05$). Lower levels of acceptance as a coping strategy were furthermore found to be a significant predictor of membership in Group 2, the delayed group (OR = 0.49, $p < 0.05$). Finally, higher social support predicted membership in the delayed group (OR = 1.74, $p < 0.05$) and lower social support predicted membership in the stable group (OR = 0.92, $p < 0.05$).

4. Discussion

The current study had two aims. The first aim was to test whether psychiatric staff who had experienced WV could be distinguished on several different PTSD trajectories across three-time points. The results of the LGMM indeed point to the existence of three PTSD trajectories: recovering, delayed and stable. The first group was characterized by an average level intercept and a significantly highly decreasing slope, meaning that the people in this group had average levels of PTSD symptoms that highly declined with time. The second group was characterized by a lower intercept and a highly increasing significant slope. The second group can therefore be said to have experienced low levels of PTSD symptomatology in the beginning, but that the symptoms increased highly with time. The third group was characterized by an average intercept and a significantly stable slope. The third group therefore experienced average levels of PTSD in the beginning that remained stable over time, however with a very small decrease. The results therefore confirm the first hypothesis of this study, which was that there would be multiple trajectory groups in the population.

Our study finds two out of the four common PTSD trajectories that have been found in the literature [7]. The existence of a recovering PTSD trajectory group that is characterized by an average intercept and a declining slope has also been established in other PTSD literature [25] [26]. The decreasing slope could be due to people experiencing heightened stress levels shortly after traumatic events, and that these reactions decrease across time. The heightened stress levels may therefore exacerbate PTSD severity in the beginning and, however, may decrease as time passes due to natural causes. This may also be true for the current sample. The delayed-onset PTSD trajectory was also found in the current analysis, as well as in other studies [7]. Increasing trajectory slopes have commonly been found in veteran samples, and an occupational trauma population might have similarities with such samples, as it happens in relation to work. Furthermore, a higher number of delayed-onset PTSD cases have in general been found in occupational trauma populations [27].

Two of the other common groups [7], the resilient and the chronic, were however not found in our sample. However, we did find a stable group, but instead of the sample consisting of severe symptoms, it consisted of individuals with moderate levels of PTSD symptomatology that remained stable. As such, the trajectory development is similar to that of the chronic group, but a possible explanation for the moderate instead of severe PTSD symptomatology could be because of the lower level of PTSD cases in our sample in general. There could be reasons to believe that when exposure to violence happens at a workplace, important differences are found between this and exposure to violence in civilian life, e.g., in the family or in the community.

The LGMM approach has been criticized to be misleading because classes can be found based on distributions of data rather than different groups in the population [28]. Others, however, disagree with the criticism and advocate the use of the technique [29] [30] [31].

The second hypothesis of the current study was that membership within different trajectory groups could be defined by several explanatory variables. We tested ASD, social support, coping strategies, cognitive appraisals, and organizational support. The results concluded that posttraumatic negative cognitive appraisals about the self, the world and self-blame predicted membership in the stable group. This is in accordance with earlier research that has found that negative cognitive appraisals play a big role in the development and persistence of posttraumatic symptoms after violence [32], in another occupational population [33] and in general [34] [35]. When testing for the meaning of coping strategies, only lower levels of acceptance were found to significantly predict membership in the delayed group. This is also in accordance with earlier research that has shown that several coping strategies can play a role in the development of PTSD after violence [32] and in general [36] [37]. The fact that not being able to accept the violent incident was related to the delayed group specifically also makes sense, as not accepting the impact of violence exposure initially can be thought to make the individual react later rather than sooner.

Finally, lower social support predicted membership in the stable group, which supports earlier research that finds that low social support is a consistent predictor of posttraumatic stress levels [18]-[38]. It is, however, a highly interesting finding that higher levels of social support were a predictor of membership in the delayed PTSD group. However, some earlier research has suggested that social support may be detrimental to recovery in some populations, as it can be seen as an unwanted burden. It can be beneficial in the immediate aftermath of trauma, which might be true in our case since symptoms are low. However, as time passes and PTSD symptoms increase as in the current population, the levels of social support can decrease if social networks start distancing themselves from the PTSD-affected individual. Likewise, the traumatized individual can begin to distance himself or herself through increasing symptoms such as avoidance and detachment [39]. The fluctuating role of social support might therefore explain

why it is significantly related to membership in the delayed PTSD group in the current study.

5. Conclusions

WC research has largely been done by means of cross-sectional studies.

The current study used LGMM on prospective PTSD data. Earlier studies that have used this technique, have not used occupational trauma samples and the current study is therefore unique in its design. We managed to identify three classes of which the large majority has a gradual symptom decrease, a substantial minority class stabilized with a high symptom level, whereas a small minority "delayed" group increased in symptoms over time.

Several well-known individual and organizational risk factors were examined, to find out whether these factors can explain the broad differences in posttraumatic symptomatology in this population. Self-blame and negative cognitions about the self-predicted membership of the large majority recovering group. These behaviors and cognitions are common and to some degree signs of responsibility but they might also be destructive over time if not properly processed. Lack of acceptance was characteristic for the group with a delayed response, while lack of social support was common in the "stable" group with high symptom levels.

Among the limitations, is the use of three measurement points only. It has been argued that three measurement points could possibly limit the complexity of the curve and that four measurement points at least should be required to allow for a deeper exploration of the prospective data (Orcutt et al., 2004). However, prospective research still has many advantages in terms of the current research questions, so the design of the study can still be seen as a strength. Furthermore, the study population is a Danish working population, and therefore, problems may arise in terms of the generalizability to other trauma victims and other cultures.

Clinical Implications

The current study indicates that not everyone who goes through a similar trauma experience will experience the same PTSD symptom severity and course. It indicated that although a large proportion of occupational trauma victims can have a very natural recovery, some people do not recover as fast and stay stable and others with mild PTSD levels can highly increase in symptoms. Therefore, the current study supports the view that resources should perhaps be more focused on other factors that might influence recovery rather than posttraumatic symptoms only. Identifying the individuals at risk of persistent PTSD symptomatology is the most essential task in regard to deciding what interventions should be instigated and when they would have the greatest positive effect.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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