

Preplanned Studies

Differences in Depression and Anxiety Symptom Networks Between Food Delivery Riders and Goods Couriers — China, 2022

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Summary

What is already known about this topic?

Platform workers' mental health is an increasing global concern. Depression rates ranged from 16.8% (67/400) to 31.9% (362/1,136), and anxiety rates from 46.0% (302/657) to 62.9% (95/151), significantly higher than general occupational population.

What is added by this report?

The prevalence of depressive and anxiety symptoms among platform-delivery workers was 22.7% [95% confidence interval (CI): 22.3%, 23.1%] and 10.4% (95% CI: 10.1%, 10.8%), respectively. Food delivery riders had significantly higher depression and anxiety symptoms prevalence than goods couriers (all $P < 0.001$). Network analysis identified "Motor disturbance" as the most central symptom in both groups (goods couriers: 1.496; food delivery riders: 1.342), followed by "Uncontrollable worry" (1.032) among food delivery riders, and "Fatigue" (1.091) among goods couriers. "Suicide ideation" served as the key bridging symptom.

What are the implications for public health practice?

Given their unique work environments, targeted interventions are recommended for both groups, focusing specific on depression and anxiety symptom networks identified in this study.

Methods: A total of 30,670 platform-delivery workers — 11,402 food delivery riders and 19,268 goods couriers — were included for final comparative analysis. A network structure of depression–anxiety symptoms was constructed. Each symptom's expected influence (EI) and bridge expected influence (BEI) were calculated.

Results: Depressive symptoms' prevalence was 22.7% [95% confidence interval (CI): 22.3%, 23.1%], and anxiety symptoms' prevalence was 10.4% (95% CI: 10.1%, 10.8%). Food delivery riders scored significantly higher than goods couriers on all items, total scales and symptom prevalence (all $P < 0.001$). Network analysis further revealed group differences: "Motor disturbance" showed the highest EI centrality in both groups (goods couriers: 1.496; food delivery riders: 1.342), followed by "Uncontrollable worry" (1.032) among food delivery riders and "Fatigue" (1.091) among goods couriers. "Suicide ideation" had the highest BEI in the combined network. The two groups also differed significantly in edge weights ($P < 0.01$), with a particularly stronger connection between "Restlessness" and "Fear without reason" among the goods courier.

Conclusions: Depression and anxiety symptoms were worse among food delivery riders than couriers. Additionally, their symptom structures differed, underscoring the need for targeted interventions for both groups.

ABSTRACT

Introduction: The platform gig economy has significantly affected labor markets worldwide, making platform workers' mental health issues increasingly prominent. However, large-scale investigations focusing on depression and anxiety symptoms among Chinese platform-delivery workers are lacking, and there is also a lack of in-depth exploration of such a relationship across different occupational subgroups. This study investigated the interrelationships between depression and anxiety and analyzed differences in their symptom networks.

Digital technologies' expansion has made gig work a significant part of China's labor market. Mental health issues faced by platform-based workers in nontraditional employment are increasingly prominent (1). Depression symptoms' prevalence ranged from 16.8% (67/400) to 31.9% (362/1,136), and anxiety from 46.0% (302/657) to 62.9% (95/151), depending on the scale and cutoff used (2). Food delivery riders and goods couriers share platform-mediated features

but face distinct occupational stressors: food delivery riders encounter extreme time constraints (3), whereas goods couriers face different physical demands (4). Previous research has focused on overall prevalence rather than potential differences in how depression and anxiety symptoms manifest between these subgroups. Therefore, we hypothesized that the structural characteristics of the depression-anxiety symptom network would differ significantly between them. This study utilized network analysis to examine symptom-level interactions to inform targeted psychological preventive interventions.

We employed a stratified cluster random sampling design across Chinese 31 provincial-level administrative divisions (PLADs) under the national Occupational Health Literacy of Key Populations (OHL) 2022 program. Within each PLAD, four districts or counties were selected using probability proportional to size sampling, and 1–3 courier and food delivery companies were randomly chosen. Eligible workers were randomly selected, targeting at least 200 workers per district (approximately 1,000 per PLAD). Data were collected via a unified web-based platform using Quick Response Codes.

Inclusion criteria: age 18–58 years; front-line platform-delivery workers; and ≥ 6 months of work experience. Exclusion criteria: inability to complete the questionnaire or diagnosed severe mental disorders. Quality control measures included electronic checks, uniform training, verification, and independent cleaning. After initial cleaning, 31,030 participants completed the questionnaire, and excluding age mismatches and logical errors, 30,670 were analyzed.

Depression and anxiety were assessed using Chinese versions of the Patient Health Questionnaire-9 (PHQ-9) and the Generalized Anxiety Disorder-7 (GAD-7) (4-point scales; Cronbach's $\alpha = 0.896$ and 0.911 , respectively). The full item contents are listed in [Supplementary Table S1](https://weekly.chinacdc.cn/) (available at <https://weekly.chinacdc.cn/>). Descriptive statistics and *t*-tests utilized SPSS (version 30.0; IBM SPSS Inc., Chicago, USA). Network analysis (R 4.5.0; The R Foundation, Vienna, Austria) estimated symptom networks, calculated expected influence (EI) and bridge expected influence (BEI), and compared groups. Detailed methods are provided in [Supplementary Methods](https://weekly.chinacdc.cn/) (available at <https://weekly.chinacdc.cn/>).

A total of 30,670 platform-delivery workers were recruited, including 11,402 food delivery riders and 19,268 goods couriers, aged 18 to 58 years (mean age = 33.87 ± 8.26 years); 23,709 (77.3%) were males,

8,802 (28.7%) had received higher education, 18,187 (59.3%) held rural household registration, and 20,840 (68.0%) were married. Additional demographic information is presented in [Table 1](#). Prevalences of platform-delivery workers depressive symptom (PHQ-9 ≥ 10) and anxiety symptom (GAD-7 ≥ 10) were 22.7% [95% confidence interval (CI): 22.3%, 23.1%], and 10.4% (95% CI: 10.1%–10.8%). Depressive symptoms' prevalence (PHQ-9 ≥ 10) was 26.6% (95% CI: 25.8%, 27.9%) among food delivery riders and 20.4% (95% CI: 19.8%, 20.9%) among goods couriers, with significant difference between the groups ($\chi^2 = 158.92$, $P < 0.001$). Anxiety symptoms' prevalence (GAD-7 ≥ 10) was 12.2% (95% CI: 11.6%, 12.8%) among food delivery riders and 9.4% (95% CI: 9.0%, 9.8%) among goods couriers ($\chi^2 = 60.45$, $P < 0.001$) ([Table 1](#)). Mean PHQ-9 score was 7.65 ± 5.13 for food delivery riders and 6.68 ± 4.88 for goods couriers, with significant difference between the subgroups ($t = -16.44$, $P < 0.001$). The GAD-7 score was 3.93 ± 4.66 for food delivery riders and 3.42 ± 4.37 for goods couriers, with a significant difference between the two subgroups ($t = -9.52$, $P < 0.001$). Notably, food delivery riders scored significantly higher than goods couriers on all individual items across both scales (all $P < 0.001$) ([Table 2](#)).

The network among all platform-delivery workers had 109/120 non-zero edges (sparsity = 0.092). Moreover, the top ten strongest edges observed in the model were distributed within respective communities of specific mental health problems, and the edge between PHQ1 "Anhedonia" and PHQ2 "Sad mood" was the strongest, followed by GAD1–GAD2 (Nervousness–Uncontrollable worry) and PHQ7–PHQ8 (Concentration–Motor disturbance). The depression–anxiety network model for both groups is illustrated in [Figure 1](#). Network comparison revealed statistically significant differences in edge weights ($M = 0.076$, $P < 0.01$), but no differences in global strength (GS: 7.612 versus 7.670; $S = 0.059$, $P = 0.48$). Regarding differences in edge weights, a strong connection was found between GAD5 "Restlessness" and GAD7 "Fear without reason" among the goods courier group (weight = 0.236), whereas this connection was weaker among food delivery riders (weight = 0.159) ([Figure 1](#)).

The EI within the entire network structure is shown in [Figure 1](#) and summarized in [Table 2](#). PHQ8 "Motor disturbance" had the highest EI value among goods couriers (1.496), followed by PHQ4 "Fatigue" (1.091). The highest EI node was PHQ8 "Motor

TABLE 1. Demographic characteristics and symptoms prevalence among food delivery riders (N=11,402) and goods couriers (N=19,268).

Variable	Total	Food Delivery Riders	Goods Couriers	χ^2	P
Gender, n (%)				1,055.67	<0.001
Male	23,709 (77.3)	9,966 (87.4)	13,743 (71.3)		
Female	6,961 (22.7)	1,436 (12.6)	5,525 (28.7)		
Marital status, n (%)				974.51	<0.001
Unmarried	8,399 (27.4)	4,206 (36.9)	4,193 (21.8)		
Married	20,840 (68.0)	6,520 (57.2)	14,328 (74.4)		
Other / Divorced / Widowed	1,423 (4.6)	676 (5.9)	747 (3.9)		
Household registration, n (%)				192.39	<0.001
Agricultural (Rural)	8,489 (27.7)	2,632 (23.1)	5,857 (30.4)		
Non-agricultural (Urban)	18,187 (59.3)	7,218 (63.3)	10,969 (56.9)		
Residential	3,994 (13.0)	1,552 (13.4)	2,442 (12.7)		
Education background, n (%)				547.98	<0.001
High school, vocational school or below	21,868 (71.3)	9,024 (79.1)	12,844 (66.7)		
Junior college	6,320 (20.6)	1,676 (14.7)	4,644 (24.1)		
Bachelor's degree or above	2,482 (8.1)	702 (6.2)	1,780 (9.2)		
Depressive symptoms, n (%)				158.92	<0.001
PHQ-9<10	23,716 (77.3)	8,370 (73.4)	15,346 (76.6)		
PHQ-9 $\geq$ 10	6,954 (22.7)	3,032 (26.6)	3,922 (20.4)		
Anxiety symptoms, n (%)				60.45	<0.001
GAD-7<10	27,472 (89.6)	10,012 (87.8)	17,460 (90.6)		
GAD-7 $\geq$ 10	3,198 (10.4)	1,390 (12.2)	1,808 (9.4)		

Note: Percentages may not sum to 100% due to rounding.

Abbreviation: PHQ-9=patient health questionnaire-9; GAD-7=generalized anxiety disorder-7.

disturbance" (1.342), followed by GAD2 "Uncontrollable worry" for food delivery riders (1.032). Regarding bridge symptoms, PHQ9 "Suicide ideation" had the highest BEI values among food delivery riders. For goods couriers, the top bridge symptom was GAD1 "Nervousness," followed by PHQ9 "Suicide ideation" (Figure 2). Both EI and BEI values indicated an excellent level of stability (CS coefficients =0.75), suggesting 75% of participants could be dropped from the analyses without significantly changing the network structure.

DISCUSSION

This study examined the network structure of depression and anxiety symptoms among Chinese platform-delivery workers, comparing food delivery riders and goods couriers. Our findings revealed that food delivery riders reported more severe depression and anxiety symptoms than goods couriers, consistent with previous research documenting the psychological

toll of time-pressured delivery work (3). Network analysis further identified distinct symptom patterns: "Uncontrollable worry" emerged as the most central symptom among food delivery riders; while "Fatigue" was one of the core symptoms among goods couriers, who also exhibited a stronger connection between "Restlessness" and "Fear without reason." Notably, the observed prevalence of depression and anxiety in our sample was lower than literature-reported ranges (2). This discrepancy likely reflects the broader definition of new employment forms, covering more diverse gig worker populations, differences in measurement thresholds across scales, and potential healthy worker effects.

The more severe symptomatology among food delivery riders likely reflects their unique occupational stress. Food delivery platforms employ intensive algorithmic management that dynamically adjusts delivery times based on real-time locations of workers, creating relentless time pressure. This urgency may amplify "Uncontrollable worry," a finding also observed in research linking platform labor control to

TABLE 2. Comparison of PHQ-9 and GAD-7 item scores between food delivery riders ($N=11,402$) and goods couriers ($N=19,268$).

Item scale	Item content	Food Delivery Riders		Goods Couriers		<i>t</i>	<i>P</i>
		<i>M</i> ± <i>SD</i>	<i>EI</i>	<i>M</i> ± <i>SD</i>	<i>EI</i>		
PHQ1	Anhedonia	0.94±0.77	-2.234	0.85±0.75	-1.974	-10.59	<0.001
PHQ2	Sad mood	0.94±0.70	0.492	0.86±0.69	0.737	-9.71	<0.001
PHQ3	Sleep	0.97±0.82	-0.776	0.87±0.79	-0.650	-10.85	<0.001
PHQ4	Fatigue	1.04±0.79	0.749	0.96±0.77	1.091	-9.32	<0.001
PHQ5	Appetite	0.91±0.78	0.049	0.82±0.73	-0.326	-9.83	<0.001
PHQ6	Guilty	0.85±0.85	0.350	0.68±0.77	0.224	-17.42	<0.001
PHQ7	Concentration	0.85±0.82	-0.064	0.74±0.75	-0.337	-11.77	<0.001
PHQ8	Motor disturbance	0.74±0.78	1.342	0.62±0.71	1.496	-13.45	<0.001
PHQ9	Suicide ideation	0.41±0.71	-1.939	0.29±0.60	-2.297	-15.44	<0.001
Total Scores of PHQ-9		7.65±5.13	-	6.68±4.88	-	-16.44	<0.001
GAD1	Nervousness	0.55±0.78	-0.759	0.49±0.74	-0.126	-6.24	<0.001
GAD2	Uncontrollable worry	0.51±0.79	1.032	0.44±0.73	0.410	-8.07	<0.001
GAD3	Worry too much	0.64±0.87	0.419	0.56±0.81	0.307	-7.57	<0.001
GAD4	Trouble relaxing	0.64±0.90	0.380	0.58±0.85	0.259	-6.23	<0.001
GAD5	Restlessness	0.52±0.82	0.741	0.43±0.75	0.523	-8.97	<0.001
GAD6	Irritability	0.63±0.87	0.544	0.56±0.81	0.736	-7.56	<0.001
GAD7	Fear without reason	0.43±0.78	-0.326	0.35±0.69	-0.072	-9.37	<0.001
Total Scores of GAD-7		3.93±4.66	-	3.42±4.37	-	-9.52	<0.001

Note: *n*: number of participants; *M*: mean; (raw node-level indices derived from the network analysis).

Abbreviation: PHQ-9=patient health questionnaire-9; GAD-7=generalized anxiety disorder-7; SD=standard deviation; EI=expected influence.

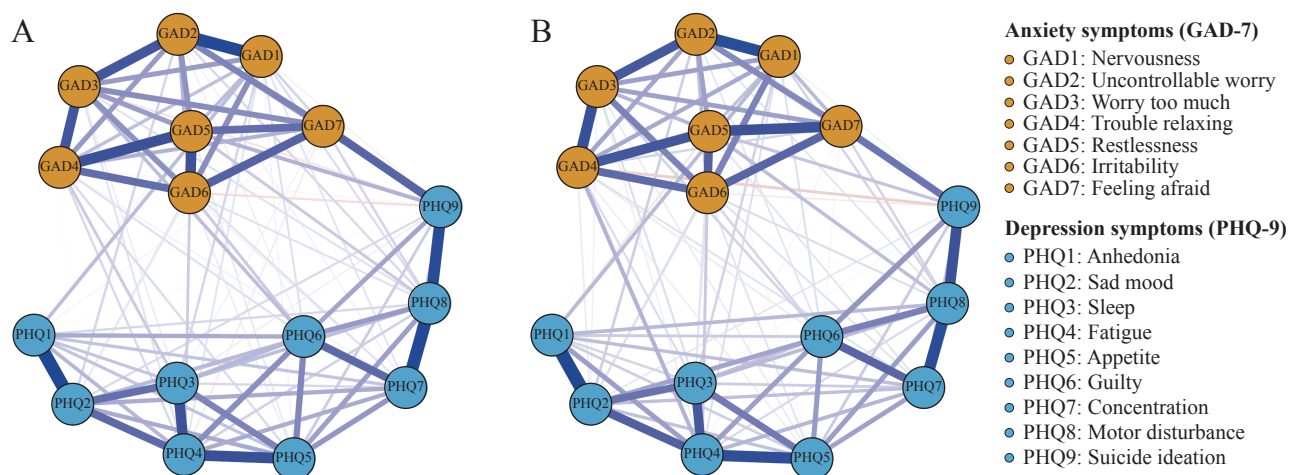


FIGURE 1. Comparison of network connections between (A) food delivery riders and (B) goods couriers.

Note: Positive correlations are indicated by blue lines, and negative correlations are marked by orange-red lines. The thicknesses of the lines reflect the strength of the correlation. The network was based on a final analytical sample of 11,402 food delivery riders and 19,268 goods couriers (total $N=30,670$).

Abbreviation: PHQ-9=patient health questionnaire-9; GAD-7=generalized anxiety disorder scale-7.

increased psychological distress (5). The occupational vulnerability of delivery workers, who lack traditional employment protections, further exacerbates this concern. Conversely, "Fatigue" was one of the most common symptoms among couriers. This aligns with a

network analysis of migrant Filipino workers, where fatigue emerged as the most central symptom (6). This reflects the physically demanding nature of platform-delivery work: quick shifting, repetitive lifting, extended working hours, and emotional labor (7).

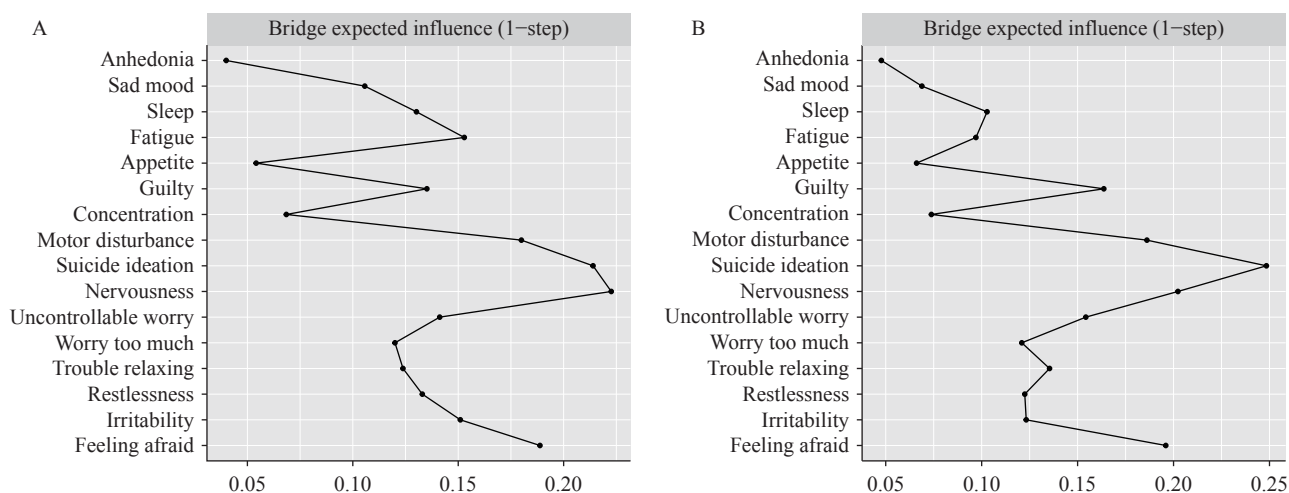


FIGURE 2. The BEI of the code network diagrams between (A) food-delivery riders and (B) goods couriers.

Note: The network is based on a final analytical sample of 11,402 food delivery riders and 19,268 goods couriers ($N=30,670$).

Abbreviation: BEI=bridge expected influence.

Meanwhile, goods couriers face persistent uncertainty regarding sudden collection requests, even after hours, because they remain accountable for parcels within designated zones and lack an offline state. This diffuse anxiety may manifest as restlessness paired with unexplained fear.

"Motor disturbance" had the highest centrality values in both groups, confirming the key node influencing the depression–anxiety symptom network and suggesting that targeted interventions may yield broader network effects (8). Additionally, "Suicide ideation" served as the primary bridge symptom connecting depression and anxiety networks. This diverges from systematic reviews of community and clinical samples, where "Sad mood" typically bridged these two conditions (9). As an important subset of the new generation of migrant workers, food delivery riders and goods couriers face time pressures from platform algorithms and social isolation, which may render suicide ideation a critical node linking depression and anxiety. Notably, "Nervousness" also demonstrated the highest bridge properties among goods couriers, consistent with a study of migrant industrial workers in Shenzhen, where nervousness similarly acted as a primary bridge symptom connecting depression and anxiety (10). For central and bridge symptoms, the depression-anxiety network of goods couriers more closely resembled that of traditional migrant workers. Conversely, food delivery riders exhibited more distinct psychological symptom characteristics, which may reflect a deeper integration of their occupational characteristics with platform

algorithms. Therefore, these differences suggest that intervention strategies should account for group-specific characteristics of the symptom network.

These findings support policies addressing the structural determinants of mental health risks among platform workers. China's recent initiatives, like the *Guidelines for Platform Labor Rules and Algorithm Negotiation (Trial)* and the expansion of occupational injury protection to all 31 PLADs by 2026, directly align with our identified symptom patterns. These symptom patterns correspond to policy efforts, like limiting working hours and enhancing algorithmic transparency.

This report's findings are subject to at least two limitations. First, due to the study's cross-sectional design, causal relationships between symptoms over time cannot be assessed. Second, the study focused on depression and anxiety networks of platform-delivery workers, with only a few elements included, and sampling weights or design effects were not incorporated. Longitudinal studies are needed to explore the causal relationships between depression, anxiety, and other factors to obtain more information on the protective and risk factors in this population. This may improve our understanding of the complex relationships between various aspects of the work environment and mental health development among platform-delivery workers.

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SUPPLEMENTAL MATERIAL METHODS

Detailed Sampling and Data Collection Procedures

Sampling proceeded in multiple stages: First, four districts or counties were selected within each provincial-level administrative division (PLAD) using probability proportional to size (PPS) sampling. Subsequently, one to three courier and food delivery service companies were randomly selected as primary cluster units within each sampled district or county. Eligible workers were randomly selected from these companies. The target was to survey at least 200 eligible workers per industry sector within each district or county, totaling approximately 1,000 platform-based delivery workers per PLAD. Data were collected using a unified national web-based platform. The OHL project team generated questionnaire QR codes, which provincial monitoring units used to conduct face-to-face, centralized survey sessions, guiding participants to complete the anonymous online questionnaire.

Quality Control

The electronic questionnaire design limited illogical data entry. All investigators received uniform training and examination. The China CDC verified the collected data, and independent statistical analysts processed, analyzed, and cleaned. After the initial data cleaning by the OHL project team, 31,030 individuals completed the questionnaire. After excluding questionnaires with mismatched age criteria or logical errors in demographic characteristics, 30,670 participants were included in the analysis.

Detailed Network Analysis

Data analysis comprised two steps. Step one (descriptive statistics and t-tests) was performed using IBM SPSS Statistics (version 30.0; IBM SPSS Inc., Chicago, USA). Step two involved network analysis using R program (version 4.5.0; The R Foundation, Vienna, Austria). Network estimation, model construction, parameter

SUPPLEMENTARY TABLE S1. The meanings of the items in the depression and anxiety scales.

Item scale	Item label	Full item question
PHQ-9		
PHQ1	Anhedonia	Little interest or pleasure in doing things.
PHQ2	Sad mood	Feeling down, depressed, or hopeless.
PHQ3	Sleep	Trouble falling or staying asleep, or sleeping too much.
PHQ4	Fatigue	Feeling tired or having little energy.
PHQ5	Appetite	Poor appetite or overeating.
PHQ6	Guilty	Feeling bad about yourself — or that you are a failure or have let yourself or your family down.
PHQ7	Concentration	Trouble concentrating on things, such as reading the newspaper or watching television.
PHQ8	Motor disturbance	Moving or speaking so slowly that other people could have noticed. Or the opposite — being so fidgety or restless that you have been moving around a lot more than usual.
PHQ9	Suicide ideation	Thoughts that you would be better off dead, or of hurting yourself in some way.
GAD-7		
GAD1	Nervousness	Feeling nervous, anxious, or on edge.
GAD2	Uncontrollable worry	Not being able to stop or control worrying.
GAD3	Worry too much	Worrying too much about different things.
GAD4	Trouble relaxing	Trouble relaxing.
GAD5	Restlessness	Being so restless that it is hard to sit still.
GAD6	Irritability	Becoming easily annoyed or irritable.
GAD7	Fear without reason	Feeling afraid as if something awful might happen.

Abbreviation: PHQ-9=Patient Health Questionnaire-9; GAD-7=Generalized Anxiety Disorder-7.

estimation, and visualization were performed within the R environment using the qgraph package (version 1.6.9) and bootnet package (version 1.4.3). The EBICglasso algorithm was selected for model estimation, integrating the Extended Bayesian Information Criterion (EBIC) with the Least Absolute Shrinkage and Selection Operator (LASSO) regularization technique to identify a sparse and stable network structure. Given the ordinal nature of PHQ-9 and GAD-7 items (4-point Likert scales), we used the default `corr="auto"` parameter in the EBICglasso function, which automatically computes polychoric correlations to appropriately handle ordinal measurement properties. The hyperparameter γ was set to 0.5 to balance specificity and sensitivity. To quantify the importance of each node, expected influence (EI) was calculated using the qgraph package. This metric is more suitable than traditional node strength for networks containing both positive and negative edges. For the bridge expected influence (BEI) analysis, communities were defined a priori based on scale structures: nine PHQ-9 items were assigned to the depression community and seven GAD-7 items to the anxiety community. The BEI was computed using the bridge function in the networktools package (version 1.2.3) to identify bridge symptoms, with higher BEI values indicating a greater risk of symptom transmission between communities. Network accuracy and stability were assessed using the bootnet package (version 1.4.3) via a case-dropping bootstrap procedure. Stability of EI and BEI centrality indices was evaluated using correlation stability (CS) coefficients, with values above 0.5 indicating strong stability. To examine differences between food delivery riders and goods couriers, a Network Comparison Test (NCT) was performed using the Network Comparison Test R package to compare global strength and specific edge weights between the two occupation-specific networks.