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# Association of Psychological Problems for Which Help Was Sought With Physical Illness

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**Introduction:** Persons with mental disorders are at increased risk for physical illness. Individuals who seek help for psychological problems might benefit from timely support and interventional approaches. This study aimed to explore the associations between psychological problems for which help was sought and physical illness.

**Methods:** The 7th survey of the Tromsø Study, which included 21,083 participants aged ≥40 years, was used in the study. The main exposure was psychological problems for which help was sought. Main outcomes were lifetime prevalence and time to onset of physical illness. Associations between psychological problems and physical illness were analyzed using logistic regression and survival analysis and adjusted for sex, birth year, smoking, education, and income. Data were collected in 2015−2016 and analyzed in 2023−2024.

**Results:** Psychological problems were associated with smoking and having lower income but higher educational attainment. Psychological problems were associated with lifetime prevalence of hypertension, coronary artery disease, heart failure, atrial fibrillation, stroke, kidney disease, chronic obstructive pulmonary disease, asthma, arthrosis, migraine, chronic pain, and cancer; ORs ranged from 1.15 (95% CI=1.04, 1.27) to 2.15 (95% CI=1.76, 2.62). Survival analysis demonstrated that individuals with psychological problems are at increased risk for subsequent physical illness; hazard ratios ranged from 1.18 (95% CI=1.06, 1.32) to 2.74 (95% CI=2.06, 3.65).

**Conclusions:** This study found that psychological problems with or without a diagnosis of mental disorder might be an important marker of increased risk for physical illness.



## INTRODUCTION

Psychological problems can be broadly defined as aspects of human behavior that cause people distress or interfere with functioning.[1] The spectrum of conditions ranging from mental distress, which leads to disability or reduction in life quality, to mental disorders, which reflect major and mild mental dysfunction, can be classified as psychological problems. Whereas mental disorders are ascertained using distinct diagnostic criteria,[2] psychological problems can include variations in feeling, thinking, and behaving.[1]

The scope and complexity of psychological problems are also reflected in the help-seeking process. Help for psychological problems might be sought from a wide range of resources, including family or other social support, community services, online resources, counseling services at the school or work, or healthcare professionals. Previous studies show that a majority of individuals with a lifetime mental disorder eventually seek professional help even though only a fraction of

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them seek help in the year of disorder onset.[3,4] Help can also be sought for psychological problems with subclinical symptoms, which do not meet criteria for a mental disorder. Therefore, the selection and breadth of help seeking for psychological problems might be influenced by several factors, such as severity or nature of the psychological problems, health literacy, feasibility of the support, access to health care, and negative perceptions associated with the psychological problems.[5,6]

Studies reporting associations between psychological problems and physical illnesses have predominantly focused on mental disorders with clinically defined diagnostic criteria: Mental disorders are associated with premature mortality, which is mostly due to general medical conditions.[7−10] Subclinical psychological symptoms without a diagnosis are also associated with significant disability and functional impairment.[11,12] Because mental health and physical health influence each other, understanding the relationship between psychological problems and physical illness will inform about risk factors and predictors of medical conditions. Early inquiry into psychological problems as a broad measure of mental health might help as a first-step approach to ensure timely support and provide opportunities for prevention and interventional approaches. However, lifelong risk of physical illness associated with psychological problems with or without a diagnosis of mental disorder has not, to the authors' knowledge, been previously studied. To address this knowledge gap, this study aimed to investigate the associations between psychological problems for which help was sought and physical illnesses in a well-characterized, population-based study.

## METHODS

### Study Population

The Tromsø Study is an ongoing population-based health study initiated in Norway in 1974.[13] This study used cross-sectional data from the 7th survey of the Tromsø Study, which was conducted in Norway in 2015−2016.[14] All residents aged ≥40 years in the Tromsø municipality ($n$=32,591) were invited to participate. The Tromsø Study started out as a combined cardiovascular risk screening and research study.[14] Because the middle-aged population is at increased risk of having cardiovascular diseases, only individuals aged ≥40 years were invited to the 7th survey. The participation rate was 65% ($n$=21,083).

This study has been performed in accordance with the Declaration of Helsinki and was approved by the Regional Committees for Medical and Health Research Ethics (REK Approval #150757). All participants gave written informed consents to the scientific use of the health survey data. The Tromsø Study has a license from the Norwegian Data Inspectorate.

### Measures

The measures were defined on the basis of the publicly available survey questionnaire.[15] The following item was used to assess the presence of psychological problems for which help was sought (referred to as psychological problems in the remaining parts of this paper): *Have you ever had, or do you have psychological problems for which you have sought help?* Response options were *no; yes, now*; and *yes, previously*. Participants were grouped into 2 categories for psychological problems as either currently or previously have had psychological problems (answered *yes, now* or *yes, previously*) or not having psychological problems currently or previously (answered *no*). For the participants who answered *yes, now* or *yes, previously*, age at onset was registered.

The presence of physical illness was determined if the individual confirmed having had or having high blood pressure (hypertension), heart attack, heart failure, atrial fibrillation, angina pectoris, cerebral stroke/brain hemorrhage (stroke), diabetes, kidney disease not including urinary tract infection (kidney disease), chronic bronchitis/emphysema/chronic obstructive pulmonary disease (COPD), asthma, rheumatoid arthritis, arthrosis, migraine, and cancer. For example, the following item was used to assess the presence of hypertension: *Have you ever had, or do you have hypertension?* Response options were *no; yes, now*; and *yes, previously*. Participants were grouped into 2 categories for each physical illness as either currently or previously diagnosed with the condition or not having the condition currently or previously. For the answers of currently or previously diagnosed with the condition, age at onset was registered. Coronary artery disease (CAD) was defined as having had heart attack and/or angina pectoris. Age at onset for CAD was measured as the youngest age at onset registered for heart attack and/or angina pectoris. Cardiometabolic illness was defined as having at least 1 of the illnesses among hypertension, CAD, heart failure, atrial fibrillation, stroke, and diabetes. Respiratory illness was determined as having COPD and/or asthma. Musculoskeletal illness was defined as having rheumatoid arthritis and/or arthrosis. Age at onset for cardiometabolic, respiratory, or musculoskeletal illness was measured as the youngest age of onset registered for the respective illnesses. The following item was used to assess chronic pain: *Do you have persistent or constantly recurring pain that has lasted for three months or more?* Response options were *no* and *yes*. Chronic pain was ascertained at the survey date, and no age at onset was recorded.

Smoking status was measured as not smoking, previously smoking, and currently smoking. Educational attainment was grouped into 3 groups as having primary/partial secondary education, upper secondary education, and tertiary education. Household income was categorized into 3 groups as low income (<350,000 Norwegian krone), middle income (350,000–1,000,000 Norwegian krone), and high income (>1,000,000 Norwegian krone).

## Statistical Analysis

Association between categorical variables was assessed using Pearson's chi-square test. Descriptive analysis was stratified by sex given that differences in health measures between females and males exist.[16,17] Differences between quantitative variables were analyzed using independent-samples *t*-test or Welch's *t*-test for unequal variances. Association between psychological problems and smoking, education, and income was analyzed using multinomial regression. The main exposure variable was psychological problems. Smoking, education, and income were the main outcome variables, with never smoking, primary education, and low income as the respective reference groups. Birth year and sex were used as covariates. Risk estimates of associations were reported as OR with 95% CI.

Bidirectional association between psychological problems and lifetime prevalence of physical illness was assessed using logistic regression. Study populations included for each physical illness are shown in Table 1. The main exposure variable was psychological problems. Lifetime prevalence of each physical illness before or after psychological problems was the main outcome variable. Birth year and sex were used as covariates in the first model. Birth year, sex, smoking, education, and income were used as covariates in the fully adjusted model. Risk estimates of associations were reported as OR with 95% CI.

Risk of physical illness after psychological problems was assessed using survival analysis with Cox proportional hazards regression.[18,19] Survival analyses using retrospective cross-sectional data and self-reported diagnosis were previously reported to investigate the predictors of onset or risk factors of medical conditions.[20–22] The main exposure variable was psychological problems. Start of risk was defined as the age at onset for psychological problems, and time to event was defined as the outcome variable.[18,19,23] Chronological order was determined using self-reports of age at onset for psychological problems and physical illness. Details of survival analysis including median follow-up time and prevalence of subsequent physical illness are shown in Appendix Table 1 (available online). Time from birth year to age at onset for physical illness was defined as the underlying time scale (outcome variable) for the participants with the physical illness. Time from birth year to age at survey date was defined as the underlying time scale (outcome variable) for the censored participants without the physical illness. In addition, time from birth year to age at onset for the earliest physical illness was defined as the

**Table 1.** Study Populations and Lifetime Prevalence of Physical Illness

| Condition | Population, *n* | Total, *n* (%) | Female, *n* (%) | Male, *n* (%) | Without psychological problems, *n* (%) | With psychological problems, *n* (%) |
|---|---|---|---|---|---|---|
| Hypertension | 20,099 | 5,509 (27.4) | 2,704 (25.8) | 2,805 (29.2) | 4,809 (27.6) | 700 (26.3) |
| CAD | 20,266 | 974 (4.8) | 269 (2.5) | 705 (7.3) | 862 (4.9) | 112 (4.2) |
| Heart failure | 20,086 | 365 (1.8) | 114 (1.1) | 251 (2.6) | 316 (1.8) | 49 (1.9) |
| Atrial fibrillation | 20,032 | 1,282 (6.4) | 535 (5.1) | 747 (7.8) | 1,087 (6.2) | 195 (7.4) |
| Stroke | 20,191 | 508 (2.5) | 194 (1.8) | 314 (3.3) | 441 (2.5) | 67 (2.5) |
| Diabetes | 20,215 | 1,052 (5.2) | 482 (4.6) | 570 (5.9) | 909 (5.2) | 143 (5.4) |
| Kidney disease | 20,130 | 658 (3.3) | 360 (3.4) | 298 (3.1) | 550 (3.1) | 108 (4.1) |
| COPD | 20,119 | 726 (3.6) | 397 (3.8) | 329 (3.4) | 561 (3.2) | 165 (6.3) |
| Asthma | 20,182 | 2,210 (11.0) | 1,271 (12.1) | 939 (9.7) | 1,814 (10.4) | 396 (14.9) |
| Rheumatoid arthritis | 19,913 | 883 (4.4) | 517 (5.0) | 366 (3.8) | 771 (4.5) | 112 (4.3) |
| Arthrosis | 19,901 | 3,602 (18.1) | 2,490 (24.1) | 1,112 (11.6) | 3,050 (17.6) | 552 (21.2) |
| Migraine | 20,111 | 2,978 (14.8) | 2,182 (20.8) | 796 (8.3) | 2,346 (13.4) | 632 (24.0) |
| Chronic pain | 18,497 | 6,908 (37.3) | 4,171 (43.0) | 2,737 (31.1) | 5,600 (35.1) | 1,308 (51.8) |
| Cancer | 20,155 | 1,536 (7.6) | 809 (7.7) | 727 (7.5) | 1,325 (7.6) | 211 (8.0) |
| Cardiometabolic | 20,331 | 7,123 (35.0) | 3,330 (31.4) | 3,793 (39.0) | 6,211 (35.2) | 912 (33.8) |
| Respiratory | 20,280 | 2,636 (13.0) | 1,482 (14.0) | 1,154 (11.9) | 2,148 (12.2) | 488 (18.2) |
| Musculoskeletal | 20,188 | 4,090 (20.3) | 2,758 (26.2) | 1,332 (13.8) | 3,480 (19.8) | 610 (23.0) |

CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease.

**Table 2.** Baseline Characteristics of Individuals Without or With Psychological Problems

| Characteristic | Female | | Male | | Birth year– and sex-adjusted association | |
|---|---|---|---|---|---|---|
| | Without psychological problems | With psychological problems | Without psychological problems | With psychological problems | OR (95% CI) | *p*-value |
| *n* (%) | 8,862 (83.3) | 1,774 (16.7) | 8,776 (90.2) | 950 (9.8) | — | — |
| Smoking | | | | | | |
| Never, *n* (%) | 3,782 (43.0) | 643 (36.5) | 3,737 (42.9) | 349 (37.0) | ref | — |
| Previously, *n* (%) | 3,798 (43.2) | 805 (45.7) | 3,864 (44.3) | 439 (46.6) | 1.34 (1.23, 1.47) | **<0.001** |
| Currently, *n* (%) | 1,208 (13.7) | 314 (17.8) | 1,117 (12.8) | 154 (16.3) | 1.54 (1.37, 1.74) | **<0.001** |
| Education | | | | | | |
| Primary, *n* (%) | 2,118 (24.3) | 328 (18.7) | 1,904 (22.0) | 185 (19.8) | ref | — |
| Secondary, *n* (%) | 2,265 (26.0) | 387 (22.0) | 2,683 (31.0) | 229 (24.5) | 0.86 (0.76, 0.98) | **0.023** |
| Tertiary, *n* (%) | 4,337 (49.7) | 1,042 (59.3) | 8,399 (48.4) | 1,563 (58.1) | 1.30 (1.20, 1.41) | **<0.001** |
| Income | | | | | | |
| Low, *n* (%) | 1,226 (14.6) | 333 (19.6) | 764 (8.9) | 142 (15.3) | ref | — |
| Middle, *n* (%) | 5,244 (62.6) | 1,042 (61.5) | 5,302 (61.7) | 594 (64.0) | 0.49 (0.43, 0.55) | **<0.001** |
| High, *n* (%) | 1,901 (22.7) | 320 (18.9) | 2,524 (29.4) | 192 (20.7) | 0.32 (0.28, 0.38) | **<0.001** |

*Note:* Boldface indicates statistical significance ($p<0.05$).

underlying time scale (outcome variable) to assess association of psychological problems with any physical illness measured in this study. Participants without reported psychological problems were determined as unaffected. Condition of psychological problems was used as the time-varying covariate. Accordingly, participants who reported psychological problems were determined as unaffected, that is, not having psychological problems until age at onset for psychological problems, and determined as affected, that is, having psychological problems from age at onset for psychological problems until age at onset for physical illness or to age at survey date, whichever came first. In the first model, associations were adjusted for birth year and sex. In the fully adjusted model, associations were assessed after additional adjustments for smoking, education, and household income. Results are reported as hazard ratio (HR) with 95% CI and plotted using RStudio.

Analyses were performed using SPSS, Version 29 (IBM SPSS Statistics for Windows, Version 29, Armonk, NY: IBM Corp) and RStudio (R, Version 4.1.1).[24] Two-sided *p*-values were adjusted for multiple comparisons using the Benjamini–Hochberg method,[25] and false discovery rate values were reported.

## RESULTS

A total of $n$=21,083 individuals participated in the 7th survey of the Tromsø Study. All individuals who responded to the item that measures psychological problems ($n$=20,362) were included in the analysis without preselection. In the study population, 52.2% of the participants were females. Females were younger than males on average (56.9±11.3 vs 57.3±11.4, $p$=0.031). Females have more often completed primary education (23.3% vs 21.8%, $p$=0.009) and tertiary education (51.3% vs 47.8%, $p$<0.001) and have less often completed secondary education (25.3% vs 30.4%, $p$<0.001) as the highest level of education. Females more often reported having low income (15.5% vs 9.5%, $p$<0.001) and less often reported having high income (22.1% vs 28.5%, $p$<0.001), whereas females and males reported having middle income at comparable levels (62.4% vs 61.9%, $p$=0.469).

In total, 2,724 participants (13.4%) reported psychological problems, and females more often reported psychological problems (16.7% of females vs 9.8% of males) (Table 2). Individuals who reported psychological problems were younger (57.5±11.4 vs 54.4±10.3, $p$<0.001). Psychological problems were associated with smoking previously or currently and were positively correlated with higher educational attainment and negatively correlated with having middle or high income (Table 2). Sex-specific differences in prevalence was present in physical illnesses (Table 1). Males more often reported hypertension, CAD, heart failure, atrial fibrillation, stroke, diabetes, and cardiometabolic illness. Females more often reported asthma, rheumatoid arthritis, arthrosis, migraine, chronic pain, and respiratory or musculoskeletal illness.

Analysis of bidirectional associations showed the link between psychological problems and lifetime prevalence of hypertension; CAD; heart failure; atrial fibrillation; stroke; kidney disease; COPD; asthma; arthrosis;

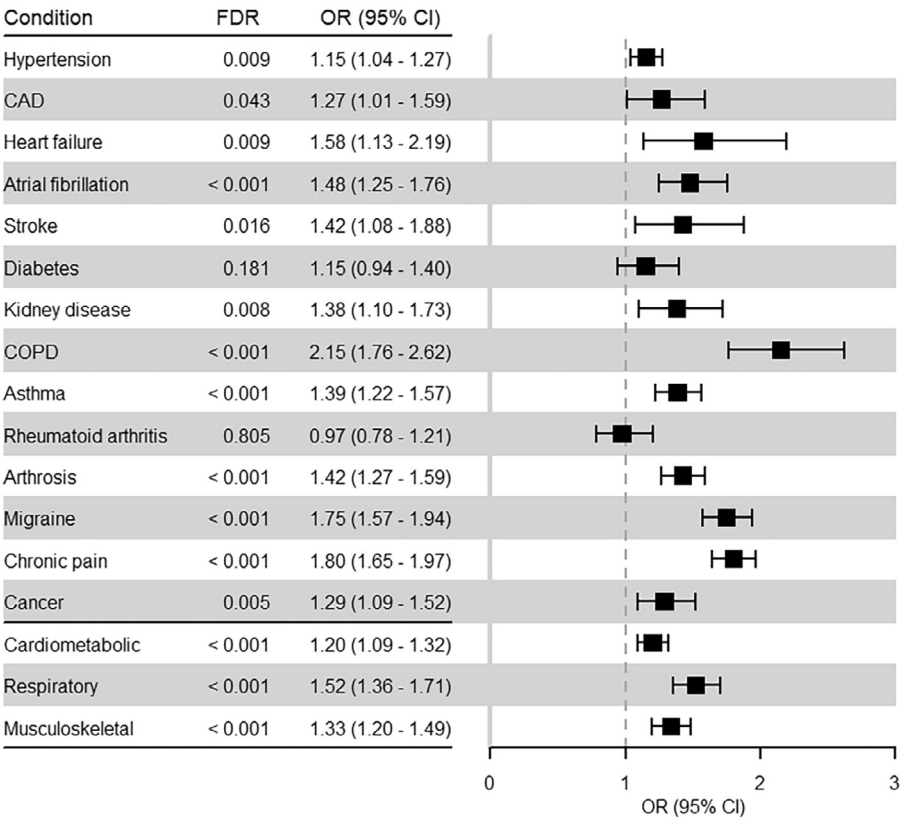


**Figure 1.** Risk estimates of association between psychological problems and lifetime physical illness in the fully adjusted model.
CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; FDR, false discovery rate.

migraine; chronic pain; cancer; and cardiometabolic, respiratory, or musculoskeletal illness; ORs ranged from 1.16 (95% CI=1.06, 1.28) to 2.44 (95% CI=2.03, 2.93) in the model adjusted for birth year and sex (Appendix Figure 1, available online). Associations between psychological problems and physical illnesses were persistent after additional adjustments for smoking, education, and income; ORs ranged from 1.15 (95% CI=1.04, 1.27) to 2.15 (95% CI=1.76, 2.62) (Figure 1). Accordingly, psychological problems were associated with cardiometabolic (OR=1.20; 95% CI=1.09, 1.32), respiratory (OR=1.52; 95% CI=1.36, 1.71), or musculoskeletal (OR=1.33; 95% CI=1.20, 1.49) illness (Figure 1).

Examining the risk of physical illness in the participants after stratification on age at onset for psychological problems showed age-group–specific associations with physical illness (Appendix Table 2, available online). Risk of cardiometabolic illness was highest in the participants who reported onset age for psychological problems between 21 and 30 years. Although the risk of respiratory illness was highest in the participants who reported onset age for psychological problems before 20 years, individuals who reported psychological problems with age at onset before 20 years or between 41 and 50 years were at increased risk for musculoskeletal illness. Distribution of reported age at onset for psychological problems and physical illness was studied in the population (Appendix Figure 2, available online). Prevalence of psychological problems peaked in adolescence and young adulthood. In contrast, prevalence of cardiometabolic and musculoskeletal illnesses peaked at middle adulthood. Age at onset for respiratory illnesses followed a biphasic pattern: prevalence first peaked in childhood and adolescence and then peaked in middle adulthood (Appendix Figure 2, available online). Reported age at onset for hypertension, CAD, heart failure, atrial fibrillation, stroke, diabetes, kidney disease, arthrosis, cancer, and cardiometabolic or musculoskeletal illness was significantly lower in individuals who reported psychological problems than in individuals who reported no psychological problems (Appendix Table 3, available online).

Next, relationship of psychological problems to subsequent physical illness was analyzed. Survival analyses adjusted for birth year and sex showed that psychological problems were associated with increased risk of multiple physical illnesses (HRs ranged from 1.17 [95% CI=1.06, 1.31] to 2.98 [95% CI=2.26, 3.93]) (Appendix

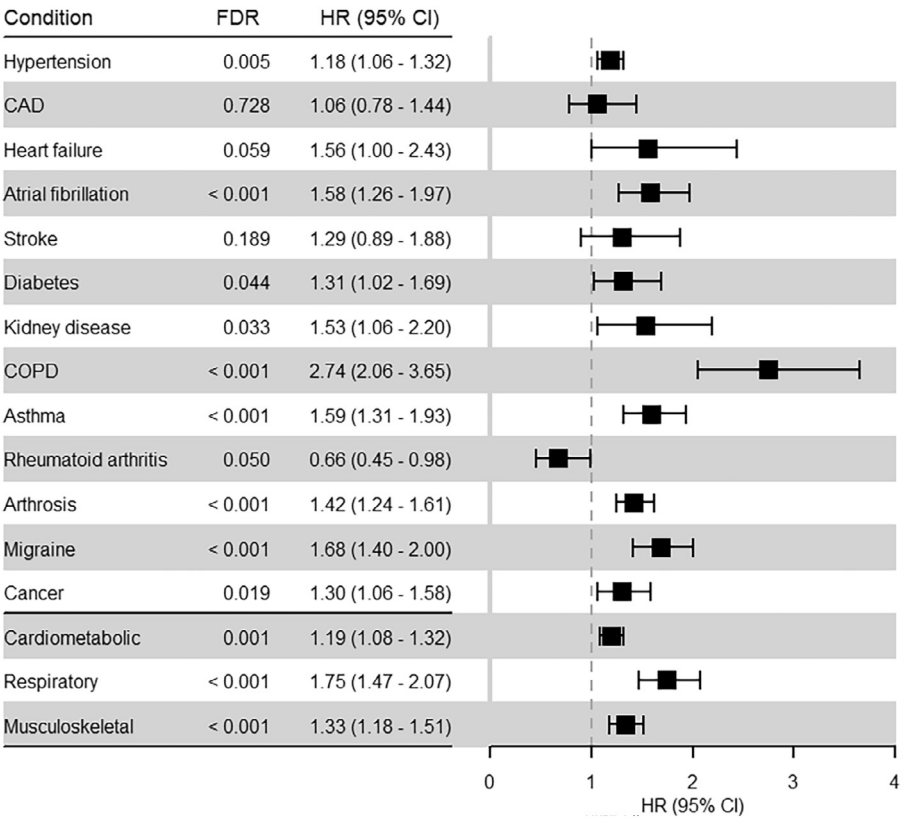


**Figure 2.** Risk estimates of association between psychological problems and subsequent physical illness in the fully adjusted model.

CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; FDR, false discovery rate; HR, hazard ratio.

Figure 3, available online). Associations between psychological problems and increased risk of hypertension, atrial fibrillation, diabetes, kidney disease, COPD, asthma, arthrosis, migraine, and cancer remained in the fully adjusted model; HRs ranged from 1.18 (95% CI=1.06, 1.32) to 2.74 (95% CI=2.06, 3.65) (Figure 2). Individuals with psychological problems were at increased risk of any physical illness measured in this study as shown by the analysis adjusted for birth year and sex (HR=1.39 [95% CI=1.29, 1.51], $p<0.001$) and by the fully adjusted model (HR=1.37 [95% CI=1.26, 1.49], $p<0.001$). Stratification on age at onset for psychological problems showed age-group−specific associations with subsequent physical illness (Appendix Table 4, available online). Individuals who reported psychological problems with onset age between 21 and 30 years and 41 and 50 years had increased risk of cardiometabolic illness. Individuals who reported psychological problems with onset age before 20 years had highest risk of respiratory illness, and individuals who reported psychological problems with onset age before 20 years and between 41 and 50 years were at increased risk of musculoskeletal illness.

## DISCUSSION

The main finding of this study is that psychological problems are associated with lifetime and subsequent risk for multiple physical illnesses. Importantly, these results suggest that psychological problems in the general population with or without a diagnosis of mental disorder is an important marker of increased risk for physical illnesses.

These findings are in line with the findings that females are more likely to seek help for mental distress or mental health problems.[26,27] Traditional sex roles and societal expectations might influence recognition of psychological problems and help seeking.[28,29] In addition, several factors that might influence psychological problems, such as sex hormones, neuroendocrine response to stress, and experienced sex-based violence, are more prevalent in females and might contribute to the observed differences.[30] Prevalence of psychological problems in this study peaked in adolescence and young adulthood, and this is consistent with the previous studies showing increased risk of mental disorders in young adult population.[31,32] Whereas there is a link between

poor mental health and low educational outcomes,[33,34] higher education is associated with help-seeking behavior in individuals with depression.[35] It is therefore plausible that individuals with higher education in this study seek help more often for psychological problems. This study showed a reverse correlation between psychological problems and income. A lower income and decreased socioeconomic status are associated with poor mental health outcomes,[36,37] which might imply inequalities in accessing healthcare services. Nevertheless, living in a socioeconomically deprived area is associated with help-seeking behavior for mental health problems.[26]

Mental disorders often coexist with physical illnesses,[10,38] and subclinical psychological symptoms are associated with measures of physical impairment.[11,12] This study adds to these findings by showing that self-reported psychological problems are associated with multiple physical illnesses in general population. The relationship between psychological problems and physical illnesses is complex and multifaceted because both psychological problems and physical illnesses might affect each other and lead to greater disability. Supporting this notion, associations between psychological problems and lifetime prevalence of physical illness indicate the occurrence of bidirectional relations. Compared with the associations with lifetime physical illness, the risk estimates were attenuated in associations between psychological problems and subsequent physical illness. One reason for this difference might be the prevalence of physical illness before psychological problems, which might influence the association between psychological problems and lifetime physical illness.

Underlying mechanisms for the associations between mental disorders and physical illness are suggested to operate at the individual level, such as genetic factors or lifestyles that act across the disorders, or at the societal level, such as poverty that can contribute to both mental disorders and physical illnesses.[38,39] In addition, adverse life experiences are risk factors for both mental and physical illnesses.[40] Although the scope of psychological problems is broader than that of mental disorders, similar causal mechanisms might explain the association with physical illness. Stress response might be an important biological mechanism linking psychological problems to physical illness. Psychological stress is suggested to induce changes in neuroendocrine system and dysregulation of autonomic nervous system.[41–43] These changes might lead to altered hemodynamic response, for example, heart rate and blood pressure, premature activation of hematopoietic cells, or increased inflammatory activation.[44,45] On the other hand, the presence of a physical illness might be a risk factor for another physical illness. For example, hypertension is linked to kidney disease and atrial fibrillation.[46] Accordingly, having a physical illness, for example, hypertension, before psychological problems might contribute to increased risk of having another physical illness, for example, kidney disease or atrial fibrillation, after psychological problems. In this study, association between psychological problems and each physical illness was assessed without measuring the effect of comorbid physical illnesses. Thus, this study supports an association rather than a causal relationship, and it remains to be investigated whether psychological problems have causal effects on physical illness or are merely predictors of increased risk for physical illness.

### Limitations

Some limitations need to be considered while interpreting the findings. Because psychological problems refer to a spectrum of mental health, various factors such as sex, age, sociodemographic characteristics, and cultural context might influence the recognition and report of psychological problems. Although this study examined physical illness in sex- and age-stratified populations, assessment of the associations between physical illness and psychological problems in young adult population or the types and severity of psychological problems was not possible owing to data unavailability. Accompanying measures to assess psychological distress and hospital records might be used in the future to establish the link between the types and severity of psychological problems and physical illness and to examine the effects of psychological problems in young adults. This study used retrospective self-reports of psychological problems and physical illness. Lifetime prevalence of retrospectively reported physical illnesses are reported to be accurate.[47] Although retrospective ascertainment of illness is common in studies,[10,48,49] underreporting due to recall might exist in this study. This study used self-report of diagnosis in assessment of medical conditions. Previous studies found that there is a strong agreement between self-report of conditions and medical records in the Tromsø Study and other studies.[50–53] Smoking status, education, and income were determined at the time of survey and used as covariates owing to cross-sectional study design. Although the large population-based sample used in this study and its agreement with findings from previous studies demonstrate validity of the findings, prospective studies will result in better understanding of the relationship of psychological problems to physical illness.

## CONCLUSIONS

Taken together, this study provides evidence that psychological problems are associated with physical illness, and individuals who seek help for psychological

problems with or without a diagnosis of mental illness are at increased risk of physical illness. Ensuring prompt help seeking and adequate mental health care in addition to screening and interventions for physical illness may therefore alleviate comorbidities, functional decline, and disability. Identifying overlapping risk factors might provide opportunities for disease management and reducing associated health burden.

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## CREDIT AUTHOR STATEMENT

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## SUPPLEMENTAL MATERIAL

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