Moving from risk to resilience in psychosis research

Katharine N. Thakkar[1,2†], Amanda McCleery[3,4,5], Kyle S. Minor[6], Junghee Lee[7,8], Clara S. Humpston[9,10], William J. Chopik[1], S. Alexandra Burt[1], Amber L. Pearson[11,12], Michael Ungar[13] and Sohee Park[14]

[1]Department of Psychology, Michigan State University, East Lansing, MI, USA
[2]Department of Psychiatry and Behavioral Medicine, Michigan State University, Grand Rapids, MI, USA
[3]Department of Psychological and Brain Sciences, University of Iowa, Iowa City, IA USA
[4]Department of Psychiatry, Carver College of Medicine, University of Iowa, Iowa City, IA USA
[5]Semel Institute for Neuroscience and Human Behavior, University of California – Los Angeles, Los Angeles, CA, USA
[6]Department of Psychology, Indiana University – Purdue University Indianapolis, Indianapolis, IN, USA
[7]Department of Psychiatry and Behavioral Neurobiology, University of Alabama at Birmingham, Birmingham, AL, USA
[8]Department of Neurobiology, University of Alabama at Birmingham, Birmingham, AL, USA
[9]Department of Psychology, University of York, York, United Kingdom
[10]Institute for Mental Health, School of Psychology, University of Birmingham, Birmingham, United Kingdom
[11]Department of Geography, Environment and Spatial Sciences, Michigan State University, East Lansing, MI, USA
[12]Department of Public Health, University of Otago, Wellington, New Zealand
[13]Resilience Research Centre, Dalhousie University, Halifax, Canada
[14]Department of Psychology, Vanderbilt University, Nashville, TN, USA

†email: kthakkar@msu.edu

Abstract

Psychosis research has traditionally focused on vulnerability and the detrimental outcomes of risk exposure. However, there is substantial variability in psychological and functional outcomes for those at risk for psychosis, even among individuals at high risk. Comparatively little work has highlighted the factors associated with resilience and the processes that might avert serious mental illness and promote positive outcomes. In this Review, we first discuss the prevailing risk-based approach to psychosis. We then outline a resilience-based approach by defining multisystemic mental health resilience and considering what constitutes a positive outcome. Based on this background, we examine evidence of biological, psychological, social and environmental protective and promotive factors that might confer resilience in the context of psychosis risk. A greater understanding of the factors and processes implicated in resilience has the potential to inform psychosis intervention and prevention efforts at multiple levels, including individuals, institutions, and policy.

[H1] Introduction

Psychotic disorders, including schizophrenia, are characterized by signs of departure from consensus reality, for example, hallucinations and delusions. This departure is often accompanied by disorganization of thought and behavior and diminished expressivity and motivation. The impact of psychotic disorders, and the discrimination and marginalization that occur in their wake, are tremendous. People diagnosed with schizophrenia have a lower life expectancy in Western countries[1], higher rates of homelessness worldwide[2-8], and drastically reduced quality of life[9] compared to those without a diagnosis of schizophrenia.

Psychotic disorders were historically viewed as irreversible and progressively deteriorating conditions that were inevitably associated with poor outcomes and disability[10]. However, in the past 30 years a more optimistic paradigm focused on psychosis prevention has emerged[11-13]. To this end, there has been a massive effort to identify factors that increase an individual's risk for developing a psychotic disorder, with the hope that targeted interventions might prevent or delay onset. Individuals seeking mental health treatment who are identified as at high-risk for psychosis show markedly increased rates of developing a psychotic disorder, relative to lifetime incidence rates in the general population[14]. However, around two-thirds of help-seeking at-risk individuals are never diagnosed with a psychotic disorder[15], and around 40% remit from high-risk status after 3 years[16]. These findings dovetail with the variability in clinical trajectories of individuals diagnosed with psychotic disorders—although many have poor long-term outcomes, over 50% show extended periods of recovery[17-21]. These data suggest the presence of internal and/or external assets and resources that can be leveraged to avert serious mental health symptoms in people with or at high-risk for psychotic disorders.

There has been comparatively little work examining those factors that might promote multifaceted positive outcomes in the face of psychosis risk. Understanding the factors that buffer against risk will help elucidate the etiological heterogeneity observed in individuals at-risk for psychosis and offer mechanistic insights into why many of them do not experience negative outcomes. Furthermore, identifying modifiable protective and promotive factors can provide important malleable targets for clinical treatments, and intervention strategies based on resilience can complement those designed to eliminate preventable risks[22]. Thus, a greater focus on resilience in the context of psychosis risk is critical for advancing the field and promoting therapeutic discovery[23].

In this Review, we first briefly summarize the literature on risk factors for psychosis and then describe the strengths and drawbacks of a purely risk-based approach. Next, we present modern conceptualizations of mental health resilience and consider what constitutes a positive outcome. Finally, we describe the factors that might confer resilience in the context of psychosis risk and conclude with recommendations for future directions. Although we focus on psychosis, many of the factors we identify throughout the Review are transdiagnostic and might convey risk and resilience for a host of psychopathological disorders.

[H1] The risk-based approach to psychosis

Converging evidence supports a diathesis-stress etiological model of psychotic disorders, whereby genetic risk interacts with social and environmental stressors to influence the development of symptoms[24-26]. There is strong evidence for a genetic contribution to the onset and maintenance of these disorders. Having a first-degree relative with a serious mental illness is one of the most well-established risk factors for psychosis. In a study of over 30,000 twin pairs spanning 50 years, concordance rates of schizophrenia were approximately 33% in monozygotic twins with an estimated heritability of 73% for schizophrenia-spectrum disorders[27].

Having a parent with a serious mental illness also increases risk for psychosis: a meta-analysis of 33 studies showed that the children of parents with serious mental illness were 6.5 times more likely to develop schizophrenia than the children of parents without serious mental illness[28]. Genome-wide association studies have also identified specific genes that confer greater risk for psychosis, with one report detecting 10 gene variants with odds ratios ≥ 3.0 for the development of schizophrenia[29]. Variations in *GRIN2A*, a glutamate receptor, and *SP4*, involved in transcription regulation, have been implicated in multiple reports as carrying greater risk for psychosis and for developmental disorders such as autism[29,30].

In terms of non-genetic risk factors, the earliest stressors might occur during prenatal and perinatal periods[31,32] and include maternal infection, medical conditions, experiencing stress during pregnancy, and complications during pregnancy or delivery. In early childhood, a variety of factors (such as early hearing impairments[33], communication deviations in parents[34], and delays in sitting, standing, or walking independently[35]) have also been associated with increased risk. These early behavioural risk factors might be secondary to prenatal and perinatal environmental risk exposure.

Social and environmental risk factors during late childhood and more proximally to illness onset (typically in late adolescence and early adulthood) have been summarized and evaluated in several meta-analyses[36] and reviews[32,36,37]. One prominent risk factor during this period is childhood trauma, which has been consistently found at high rates among individuals who later develop psychosis[38,39]. There is also extensive evidence that stressful life events in adulthood are associated with an increased risk for subclinical psychotic symptoms and a psychotic disorder diagnosis[40]. In the past decade, there has been increased focus on the role of discrimination as a risk factor for psychosis. Higher rates of subclinical psychotic symptoms, psychotic experiences, and psychotic symptoms have been found in individuals from communities that have been marginalized on the basis of race and ethnicity[41,42] as well as in sexual and gender minority communities[43], and structural racism in the United States has been explicitly linked with psychosis risk[44]. Finally, the environment where one lives and who inhabits those spaces plays an important role in the development of psychosis. A meta-analysis of eight studies and nearly 46,000 people found that the risk for schizophrenia was 2.37 times higher in urban areas than in rural environments[45]. Exposure to such environmental stressors might account for the widely replicated finding of increased stress-sensitivity in individuals with psychosis[46,47,48]. Here stress sensitization, whereby the response to some environmental stressor increases in intensity with repeated exposures, transpires and results in enduring alterations in stress-sensitivity.

This vast body of evidence describing factors that are associated with an increased risk of psychotic disorder onset has contributed to the development of mental health policies and practices that emphasize the importance of reducing the burden of these disorders in the population [49,50]. Over the past 30 years the clinical high-risk paradigm[13], which aims to identify individuals in the prodromal phase of a psychotic disorder as part of a preventative approach, has been the major focus within psychosis research. Current criteria define individuals at clinical high-risk as those who have either attenuated psychotic symptoms, full psychotic symptoms for a brief period, or substantial genetic risk paired with functional decline. Formal risk calculators have been created to enhance prediction of which individuals identified at clinical high risk will transition to psychosis[51,52]. These enhanced predictive models represent an important strength of risk-based approaches. Moreover, studies of risk can also help quantify how much risk is conveyed by specific factors. For example, according to meta-analyses the odds of experiencing childhood trauma is almost 3 times higher[37] and the odds of perceived discrimination is almost twice as high[40] among individuals who later develop psychosis

compared to controls. A risk-based approach also has important clinical implications for help-seeking youth. Early identification permits both preventative care and intervention earlier in the course of illness. This is important because shorter durations of untreated psychosis are associated with better prognosis post-diagnosis[53,54] (but see[55]), and reducing the duration of untreated psychosis is a major emphasis of treatment programs. Finally, identifying individual risk factors can enable increased personalization of treatment on the basis of specific risk exposure. Thus, a focus on risk factors sets the groundwork for treatment development and treatment targets, usually aimed at eliminating preventable risks.

Despite these strengths, relying solely on a risk-based approach for psychosis, where risk is an event or context that is directly associated with poor outcomes, has several shortcomings[56]. For example, relying solely on risk might lead to over-prediction of risk[57] and, accordingly, suboptimal treatment planning such as excessive or unnecessary interventions. Indeed, up to 70% of people identified as high-risk do not develop a psychotic disorder within three years[14,58-60]. This percentage is even higher in studies that use broader recruitment strategies, resulting in samples that are less biased towards help-seeking individuals with more severe subclinical symptoms[61-67]. Furthermore, opportunities to develop novel treatments might be limited given that the risk factors that have received the most robust support (for example, subclinical psychotic experiences and genetic risk) do not easily lend themselves to therapeutic innovation. Indeed, meta-analytic findings indicate that no specific preventative interventions have yet been identified[13,68]. In addition, an exclusive focus on risk and deficits might exacerbate the stigma associated with psychosis[69-71,72,73], which is itself linked to poor mental health outcomes[74,75].

Finally, a risk-based perspective spotlights vulnerability and fails to consider the possibility that individuals who are highly sensitive to negative contexts might also be most responsive to the enhancing effects of positive contexts—a pattern described by the differential susceptibility model[76]. That is, individuals at high-risk for psychosis might also be particularly sensitive to the beneficial effects conferred by internal and external resources and assets. A large population-based study showed that individuals with high levels of childhood adversity had more dramatic changes in mental health during adulthood as a function of both increases and decreases in life stress across the lifespan compared with individuals with low levels of adversity[77]. These findings suggest that childhood adversity might function as a differential susceptibility factor that increases responsiveness to both negative and positive contexts later in life.

In sum, the transition rates of high-risk individuals are higher than incidence rates of psychotic disorders in the general population and therefore a risk-based approach is useful for identifying individuals who will develop a disorder. But an approach purely focused on negative outcomes neglects valuable information about what is protecting those at high-risk from developing psychotic disorders or other severe mental health outcomes and—perhaps more importantly—what helps people function and thrive despite risk factors[78,79]. Risk-based approaches can be complemented by resilience-based approaches that focus on the access to resources and cultivation of assets and strengths that help people weather atypical risk in ways that yield positive outcomes.

[H1] The resilience-based approach

In this section, we define resilience and discuss the challenges in defining positive outcomes in the context of psychosis. Modern research on human resilience originated largely from the child development literature that aimed to identify factors that lead to positive adaptation despite early adversity. We provide relevant background bridging the gap between this developmental literature and the interpretation and contextualization of resilience factors in psychosis.

[H2] Defining resilient processes.
Resilience is the process by which a system (an individual, a community, or a biological entity) fares better than expected given exposure to some risk or adversity that threatens functioning[22,80,81]. Central to this definition is that resilience is a process—not a stable trait—in which protective and promotive factors support recovery, persistence, resistance, or adaptation (**Figure 1**). Furthermore, because human development across the lifespan transpires within a set of interacting systems[82], individual resilience is inherently multisystemic[83]. Specifically, human resilience can be conceptualized as a network of protective and promotive factors that confer positive outcomes and span multiple interacting subsystems or levels ranging from individual biology (such as genes) to the natural environment (such as green space) [83].

Resilience can only be studied in the context of risk or adversity. In the context of psychosis, risk might refer to factors that increase the chance of a psychotic disorder diagnosis, the experience of those symptoms (for example, experiencing persistent hallucinations might be a source of psychological distress[84]), or secondary factors that might emerge after a diagnosis of psychotic disorder (for example, poor physical health or discrimination[85,86]). Vulnerabilities and protective factors moderate the impact of risk and lead to outcomes that are worse or better than expected, respectively (**Box 1**). That is, a vulnerability factor intensifies the maladaptive outcomes in response to risk exposure and a protective factor reduces them[87]. Note that the terms 'vulnerability factors' and 'protective factors' refer to the mechanisms by which these factors exert their effects on a specific set of outcomes given a specific risk[88]. That is, vulnerability factors are not inherently bad and protective factors are not inherently good. Protective factors are distinguished from promotive factors. Promotive factors are associated with positive outcomes regardless of risk exposure; promotive effects are indicated by a main effect of a particular factor on a positive outcome measure. By contrast, protective factors are associated with positive outcomes in a risk-dependent manner and are indicated by an interaction effect, where the magnitude of association between the factor and the positive outcome is moderated by risk status. For example, social support would be considered a protective factor in the context of psychosis risk if it showed a stronger association with positive outcomes in young adults at clinical high-risk for psychosis than in a population sample of young adults; however, social support would be considered promotive if it was associated with positive outcomes regardless of clinical high-risk status.

[H2] Defining positive outcomes.
In the context of mental health, positive outcomes include functioning that aligns with or exceeds developmental or contextual norms. Defining a positive outcome that is indicative of a resilient process is challenging for several reasons. First, positive outcomes are multifaceted and include both developmental competence (for example, academic and occupational achievement, interpersonal competence, completing developmental milestones) and mental health[89]. Importantly, although a person might exhibit resilience in some aspects of functioning or mental health, few people are resilient in all domains[90]. Longitudinal studies of recovery in people with schizophrenia have revealed that positive functional outcomes (such as increased community integration) are independent of mental health outcomes such as reduced depression[91]. There is further nuance within psychological health, which entails both subjective well-being and the absence of distress or diagnosis[92-96]. Indeed, well-being and psychopathology are not two sides of the same coin. For example, some teens exhibit high well-being despite significant psychopathology; others conversely exhibit low well-being without significant psychopathology[92]. Positive mental health outcomes in the context of psychosis risk go beyond the absence of distress or formal diagnosis and measurements should include all dimensions of psychological health.

Second, who defines a positive outcome is shaped by power dymanics[97] and which individuals or systems benefit from a particular outcome must be carefully considered. The priorities of the health care systems, clinical care providers, and families might not always overlap with the priorities of the individual with psychosis. Research in psychosis prevention and recovery has traditionally focused on the absence of clinical psychotic symptoms and identifying the factors that prevent, delay, or reduce psychosis. This narrow definition diverges from the richer qualitative and psychosocial descriptors of well-being in individuals with psychotic disorders, whereby personal recovery is not necessarily contingent on clinical recovery[98-101]. To individuals seeking treatment, symptom remission alone might be insufficient to achieving a positive outcome. Rebuilding or regaining a meaningful life is central to recovery from psychosis, together with symptom management. Qualitative studies suggest that some positive changes at individual, interpersonal, and spiritual levels can occur for many individuals and their caregivers after the first episode of psychosis, despite broadly negative experiences[102]. Furthermore, a rich literature in phenomenological psychiatry has highlighted that some aspects of psychosis, which are considered to be a clinically negative outcome, might in fact provide an individual with meaning and relief and thereby confer resilience. An illuminating example is the case of delusions (**Box 2**).

Although objective and subjective indicators of well-being and quality of life are increasingly being used as outcome measures in psychosis research[103], frequently used scales might not align with the qualitative descriptions provided by mental health service users[104]. Taken together, current metrics of positive outcomes might not fully capture the heterogeneity of individual experience. Whilst efforts to quantify outcomes into categories and metrics are pragmatic and valid solutions to capturing subjective illness experiences, much is lost in the process. The result is that the vast scope and richness of meaning embedded in the internal landscape of individuals with psychosis-spectrum conditions are reduced to impoverished ratings that obscure the phenomenology of lived experience.

[H1] Resilience factors for psychosis

Meta-analyses have highlighted a striking dearth of studies investigating the factors that lead to positive mental health and functional outcomes despite psychosis risk[105,106]. In this section, we review potential promotive and protective factors in the context of psychosis risk with the aforementioned limitations and challenges in defining positive outcomes in mind. Protective and promotive factors are identified as those for which increased levels lead to increases in positive outcomes. We include potential protective and promotive factors that: decrease the chances of being diagnosed with a psychotic disorder in individuals at clinical high-risk and in general population samples; promote well-being and daily functioning and reduce relapse in individuals diagnosed with a psychotic disorder; and distinguish individuals experiencing psychotic symptoms that do and do not require care (such as those for whom auditory hallucinations cause impairment or disability versus those for whom auditory hallucinations are not distressing and often perceived to have a positive impact[84,107]).

The reviewed promotive and protective factors (**Table 1**) are organized by interacting levels of a biopsychosocial-ecological system that supports resilience of an individual (**Figure 2**). We include distal factors that might precede the onset of psychosis (for example, those occurring in childhood) as well as factors that would be expected to play a proximal role in promoting positive outcomes and buffering against more immediate risks (for example, current health behaviors). We recognize that these factors do not necessarily fit neatly into one level but rather behave as a cross-level system and are expected to exert their effects via their interactions[83] (**Box 3**). Finally, this review of resilience factors is not exhaustive but is intended to provide an

300 overview to identify trends and offer a basis for future work. Across categories the factors
301 reviewed were chosen based on the breadth of the evidence base (factors that were identified in
302 only a single study are not included). We furthermore focused our review on modifiable factors,
303 which likely have more proximal clinical implications. For a broader discussion of biological
304 resilience factors see ref[31] for a review of prenatal and perinatal factors and refs[108,109] for
305 reviews of neuroimaging findings.

306

307 [H2] Biological factors
308 In this section, we focus on three potentially modifiable protective and promotive factors at the
309 biological level: sleep, physical activity, and homeostatic regulation of the autonomic nervous
310 system.

311

312 Better sleep quality is associated with better mental health and well-being in the general
313 population[110], particularly among young adults[111], and interventions to improve sleep quality
314 decreased paranoia and hallucinations in college students with psychotic-like symptoms[112].
315 However, sleep quantity has a non-linear relationship with mental health. Although sleep
316 deprivation can precede the onset of psychosis[113] and is associated with impaired cognitive
317 function and reduced physical and mental well-being[114], excessive sleep quantity is associated
318 with increased depression and negative affect[115]. It is therefore possible that there is an optimal
319 amount of sleep that confers mental health benefits in the context of psychosis risk; however,
320 these optimal sleep parameters still need to be determined.

321 Physical activity also promotes mental health benefits in the general population[116-118] even at
322 lower levels of intensity [119-121] than the current World Health Organization recommendations[122]
323 (but see ref [123]). Physical activity during childhood protects against later psychotic symptoms in
324 children with multiple adverse childhood experiences[124] and in the general population[125,126].
325 Moreover, increased physical activity is associated with increased well-being and functioning,
326 improved cognitive performance, and reduced psychiatric symptoms in those with psychotic
327 disorders[127-131]. Akin to sleep quantity, physical activity has protective and promotive effects at
328 low to moderate, but not high, levels[132].

329 Finally, homeostatic regulation of the autonomic nervous system in response to moment-to-
330 moment demands might be a biological correlate of adaptive capacity[133,134]. In individuals with
331 normal cardiac function, higher resting state heart rate variability and respiratory sinus
332 arrhythmia are associated with better emotion regulation[133,135] and cognitive performance[136,137],
333 whereas low heart rate variability and respiratory sinus arrhythmia suggest a rigidity of
334 autonomic response and are associated with poor physical[136,137] and mental health[135,138].
335 People with psychotic illness have lower resting state heart rate variability and respiratory sinus
336 arrhythmia compared to controls[139-143], and individual differences in heart rate variability and/or
337 respiratory sinus arrhythmia have been associated with emotion regulation[144], psychiatric
338 symptom burden[142], cognitive performance[143,145,146], and functioning in this clinical population[142-
339 146]. Notably, these autonomic responses are malleable through biofeedback training [147-150],
340 breathing retraining[147,150], mindfulness practice[151], and physical exercise[149,152]. Two studies of
341 heart rate variability biofeedback training in individuals at-risk for psychosis suggest potential
342 benefits to both autonomic activity and clinical symptoms[153,154].

343 [H2] Psychological factors
344 The psychological factors that have garnered significant support as potential protective and
345 promotive factors in the context of psychosis risk can be roughly organized into three main

categories: traits and personal characteristics; attitudes, cognitions, and orientations; and psychological abilities.

[H3] Traits and personal characteristics

Adaptive coping —a cognitive or behavioral process that has long-term benefits for minimizing stress[155,156] — is associated with less severe psychotic-like symptoms in both the general population[157,158] and in at-risk youth[159] and is correlated with reduced symptom severity and increased quality of life in individuals diagnosed with schizophrenia[160-164]. One longitudinal study found that adaptive coping at baseline was associated with attenuated clinical symptom severity and better social functioning one year later in youth at high-risk for psychosis, suggesting a causal effect of adaptive coping on outcomes[165]. Relatedly, some emotion regulation strategies might also confer resilience in the context of psychosis risk. Trait use of reappraisal strategies, which aim to modify the meaning and impact of emotion-eliciting events, is associated with less severe psychotic-like experiences[166] and protects against the distress of these experiences[167].

Self-esteem, locus of control, and personality dimensions might also confer beneficial effects. Higher self-esteem is associated cross-sectionally with reduced psychotic and psychotic-like experiences in at-risk youth[168,169], improved quality of life[170] and reduced suicidality in individuals diagnosed with schizophrenia[171], and protects against distress associated with persistent psychotic experiences[172]. Longitudinal studies have shown that baseline self-esteem is associated with a lower likelihood of psychosis onset 3 years later in the general population[173]. Internal locus of control refers to the degree to which an individual feels that they are responsible for their own outcomes and is associated with a number of positive outcomes in the context of psychosis risk. Qualitative studies indicate that individuals experiencing their first episode of psychosis identify loss of control as their primary psychosocial problem[174], and regaining self-efficacy is a major component of recovery[175]. In addition, an internal locus of control might buffer the effect of harsh parenting on later psychotic symptoms[176]. Among individuals with auditory-verbal hallucinations, the ability to exert volitional control over voices is one of the main characteristics that distinguishes individuals who seek treatment from those who do not[177,178]. Finally, broad personality domains such as openness, extraversion, and emotional stability (the inverse of neuroticism) protect against the distress surrounding delusional ideas[179]. In people with schizophrenia, emotional stability, extraversion, and agreeableness are also related to better subjective quality of life and might buffer against some of the negative impacts of traumatic experiences[180-182].

[H3] Attitudes and orientations

In the context of psychosis risk, there are three candidate protective and promotive factors and processes that represent attitudes, cognitions, or orientations that might contribute to positive outcomes: stigma resistance, spirituality and/or religiosity, and meaning-making around unusual experiences. These three factors are a part of a broader category of attitudes and orientations that help people contextualize psychological experiences.

Public stigma about mental illness, which manifests in negative beliefs and attitudes about people with mental illness and overt discrimination[183], can result in internalization of those negative attitudes[184]. Self-stigma is associated with negative clinical outcomes[185,186], whereas the capacity to counteract or be unaffected by stigma (stigma resistance) is related to well-being and quality of life in individuals with psychotic disorders[187-189]. Importantly, cognitions about stigma (for example, rejecting stigma as unfair), rather than perceived stigma (for example, the observed level of stigma against people with mental illness) predicted help-seeking in those with psychosis[190]. Although more work is needed to evaluate interventions that boost stigma resistance in individuals with schizophrenia, there is evidence that self-stigma reduction

397 strategies, such as providing psychoeducation about the illness experience and the
398 consequences of stigma and teaching methods for reducing self-stigmatizing attitudes, can
399 improve psychological outcomes[191,192].
400
401 Spirituality generally confers benefits to mental health[193,194]. Spirituality (commonly defined as
402 "the search for the sacred"[195]) is related to self-reported adaptation in the face of adversity
403 among individuals diagnosed with a psychotic disorder [196]. Furthermore, sensing the presence
404 of the divine is associated with better social functioning in individuals at clinical high-risk for
405 psychosis[197]. Individuals with non-distressing psychotic experiences report being more spiritual
406 (but not religious) than individuals diagnosed with a psychotic disorder or community controls
407 without a history of psychotic experiences[172] and are more likely to ascribe voices to a spiritual
408 being rather than real people[198]. Although one interpretation of these findings is that spiritual
409 practices increase the likelihood of hearing voices, qualitative and mixed method
410 phenomenological studies instead suggest that spiritual practices and beliefs generally do not
411 precipitate the onset of voices[199,200]. Instead, these practices and beliefs play an important role
412 in controlling voices and interpreting the nature of these experiences, thereby buffering against
413 their potential negative impacts.
414
415 The protective and promotive effects of religion are more complex. Although religion often
416 includes spiritual components, they are enacted in the context of a structured system and
417 sanctioned set of beliefs, practices, and rituals[193]. Religion might act as both a vulnerability
418 factor as well as a protective or promotive factor. On the one hand, religious delusions are
419 common in individuals diagnosed with a psychotic disorder[201], thereby calling into question the
420 role of religious beliefs and practices in symptom etiology. Indeed, some studies have reported
421 relationships between greater religiosity and more severe symptoms and worse functional
422 outcomes in individuals diagnosed with a psychotic disorder[193,202]. Furthermore, in individuals at
423 clinical high risk, increased participation in religious activities was associated with more severe
424 depressive symptoms[197]. On the other hand, religious involvement within a community of
425 believers wherein beliefs and values have been adopted over generations has also been found
426 to confer benefits to mental health[193]. Qualitative studies[203,204] and data suggesting that religious
427 beliefs protect against suicidal behaviors[205] and promote quality of life[196] attest to a possible
428 protective effect of religious beliefs and practices in individuals diagnosed with schizophrenia.
429 The effects of religion on well-being and mental health might depend on cultural influences.
430 Higher rates of religious beliefs and activity are reported among ethnic minority communities in
431 Europe, the United States, and Australia compared to ethnic majority communities, and there is
432 greater use of religious coping in marginalized and/or socially disadvantaged groups[206-209].
433
434 Expanding beyond the global meaning structures provided by religion and spirituality, personal
435 appraisals of anomalous experiences influence outcomes in individuals with psychosis or
436 psychotic-like experiences. For example, compared to voice-hearers with a need for care, non-
437 treatment seeking voice-hearers often integrate psychotic experiences with their personal
438 context via intra-personal processes or acceptance from others[210,211], leading them to ascribe
439 meaning and purpose to the experience. Activities whereby individuals with schizophrenia make
440 sense of symptoms and other illness-related experiences and integrate them into their own
441 personal narratives promote well-being[212] and are a central aspect of mental health services
442 associated with positive outcomes[213]. The potential benefits conferred by meaning-making
443 processes are further highlighted by findings from a longitudinal study in India, which found that
444 having insight into one's mental health condition while also holding non-medical explanations for
445 the illness experience was associated with remission within five years following a schizophrenia
446 diagnosis[214].
447

[H3] Abilities

Psychological abilities that might serve as protective or promotive in the context of psychosis include social competence and neurocognitive abilities. Social competence entails having the skills needed for successful social functioning, which include the ability to verbally and non-verbally communicate with others, to interpret communication from others, and to regulate oneself during social interactions[215]. Social skills training has been found to be protective against relapse in patients with psychosis[216] and to reduce the risk for and severity of psychotic-like experiences in individuals with a history of adversity[217,218]

A rich literature suggests that general cognitive functioning (measured using tests of general intelligence) and specific neurocognitive abilities have protective or promotive effects. First, better neurocognitive abilities[219], particularly verbal fluency, verbal and visual memory, and working memory, are associated with a decreased risk for transitioning to psychosis in high-risk youth[220,221]. Second, individuals with higher general cognitive functioning and better executive functioning early in the course of illness have a greater chance of a resilient illness trajectory[222]. In addition, better general cognitive functioning attenuates the relationship between a history of multiple adverse childhood adverse experiences and later psychotic symptoms[223]. Finally, on average, individuals with persistent psychotic experiences who do not seek help have higher general cognitive functioning than those that do seek help[172].

[H2] Social factors

Social factors are strongly linked with mental health[224]. Greater social support is related to reduced psychotic experiences in young adults with significant psychosis risk factors[124,223,225-227], and to reduced symptom severity[203,228,229] and improved functioning[229] in people diagnosed with a psychotic disorder. A meta-analysis further indicates that family interventions aimed at improving family support are associated with reduced relapse rates[216]. These benefits are not derived exclusively from receiving support, but also from giving support. Relationship reciprocity (the mutually beneficial exchange of support) is higher in individuals with persistent psychotic experiences that do not have a need for care, versus those who do[230]. Furthermore, help-seeking individuals with psychosis reported the highest distress from their symptoms when relationship reciprocity was low, regardless of symptom severity[230]. Relatedly, in individuals with schizophrenia, better relationship quality is related to reduced symptom severity[231] and predicts better functional outcomes three years later[232]. In individuals at clinical high risk for psychosis, better quality of relationships and number of relationships are related to reduced severity of psychotic experiences and better functioning[233].

Social network size and social interactions are additional factors associated with positive outcomes [234]. For example, interactions with friends predicted two-year clinical recovery in people diagnosed with a psychotic disorder[235], living with someone else predicted remission in a prospective 20-year follow-up study of individuals experiencing their first episode of psychosis[236], and the immediate presence of family or friends decreased the moment-to-moment risk of mental states associated with delusions in individuals with chronic schizophrenia[237]. Number of relationships is associated with a reduced risk of developing schizophrenia 15 years post-baseline[238] and is further associated with reduced symptom severity in individuals diagnosed with schizophrenia[231]. At broader social levels, involvement in activities that align with interests and values also provides mental health benefits. Withdrawal from extracurricular activities has been found to precede a delusional moment[237], and holding valued social roles (for example, club membership) prevents relapse in people with psychosis[239].

Finally, broader aspects of the social environment play a crucial role in mental health. Epidemiological studies have shown that living among people of the same ethnicity reduces the chance of developing psychosis[240-242]. However, findings that neighborhood ethnic diversity has negative impacts on well-being and health are contested[243,244], and negative impacts might even reverse over longer periods of intergroup contact[245]. The mechanism underlying the association between ethnic diversity and psychosis is unclear but is almost certainly culturally-dependent[244]. One possibility is that higher ethnic density reduces exposure to discrimination and racism or exerts a buffering effect against their negative impacts[242,246]. Alternatively (or in addition), higher ethnic density might increase positive social neighborhood characteristics, at least in the short-term[244]. These social characteristics of the neighborhood confer beneficial effects in the context of psychosis risk, although work here is more limited[244]. Residing in a more socially cohesive neighborhood (that is, a neighborhood that fosters a sense of belonging[247]) is associated with a reduced risk for psychotic symptoms in children of mothers diagnosed with schizophrenia[227] and attenuates the association between adverse childhood events and later psychotic symptoms[124,223]. Finally, higher social capital (a community's bank of trust and expectations regarding reciprocity that fosters and facilitates collective action, generally measured by civic engagement[248]), has been associated with a reduced risk of developing a psychotic disorder[249-251], but findings are mixed[252]. Taken together, these findings align with the 'social defeat' hypothesis, whereby repeated experiences of social exclusion increase risk for schizophrenia[253,254]. Resilience factors at the social environmental level might buffer against these risks.

[H2] Built and natural environments

Mental health benefits can be conferred by broader aspects of the natural and built environment. There is robust evidence that access to green and blue space[255] and exposure to natural sounds[256] increase positive affect and social engagement, reduce stress levels and negative affect, improve sleep quality and cognition, and enrich meaning in life. Notably, epidemiological studies have shown that exposure to natural green and blue space during childhood is associated with psychosis risk[257-260], independent of urbanicity, and increased levels of green space density are associated with decreased schizophrenia risk in a dose-dependent manner in man-made areas[258]. Furthermore, exposure to green spaces is related to better clinical symptoms in individuals diagnosed with schizophrenia[261].

The mechanisms by which green space exert protective or promotive effects are not yet determined. Current theories suggest that natural settings foster restoration from mental fatigue[262], promote relaxation, and/or enhance well-being owing to an innate preference for life forms and lifelike processes[263]. Qualitative evidence suggests that spending time in open green space might buffer against the stress of living in an urban environment in individuals with schizophrenia[264]. Importantly, forest therapy[265,266] (a guided outdoor healing practice) is broadly promotive for a range of mental health conditions. Even simulated or virtual forest walks might confer psychological benefits[267,268]. A recreational program involving a walk through a suburban forest reduced negative affect and anxiety in individuals hospitalized for psychosis[269]. Given the known beneficial effects of the natural environment on mental health, expansion of green and blue space in urban areas, and even within buildings, seem warranted[270].

Characteristics of the built environment such as walkability, transit access, or housing quality have also been shown to contribute to positive mental health outcomes[271-273]. There has been little direct investigation into how aspects of the built environment confer resilience in the context of psychosis risk. However, several studies have shown that neighborhood walkability increases physical activity in individuals with schizophrenia[275-277], which might in turn lead to mental health

benefits. Furthermore, the built environment influences access to care[278], and therefore high-quality built environments might be associated with better outcome trajectories via access and adherence to treatment. Indeed, a study in China showed that individuals with schizophrenia living in neighborhoods with high walkability had lower re-hospitalization rates than those living in less walkable neighborhoods[274]. These findings underscore the crucial role of judicious urban planning, smart policies, and architectural design in public health outcomes.

[H1] Limitations of the resilience literature

There are several limitations to the literature reviewed above. First, it does not distinguish protective from promotive factors. Most of the factors associated with positive outcomes in the context of psychosis risk reviewed above are widely regarded as good for health, well-being, and functioning and are potentially promotive factors. Whether these factors also have a differentially positive effect in contexts of heightened risk, particularly in the context of psychosis risk (protective factors), remains unclear[279]. Answering this question would require evaluating whether a given factor was associated with positive outcomes in a risk-dependent manner. For example, spirituality could be considered a protective factor in this context if it showed a positive relationship with subjective well-being in youth identified as clinical high-risk for psychosis, but no relationship in a population sample of young adults. Distinguishing protective and promotive factors is important for developing implementation strategies. Should a factor be broadly promotive, then intervention or prevention efforts aimed at enhancing that factor stand to be effective when delivered to a wide audience through broad public health initiatives. By contrast, strategies aimed at shoring up protective factors in the context of psychosis risk might be most effective when delivered to population subgroups, such as at psychosis specialty clinics.

Second, although modern conceptualizations of resilience highlight its multisystemic nature[83], the majority of reviewed studies have focused on biological and psychological factors at the level of the individual and immediate family unit. Assets and activities within broader social and ecological levels that confer substantial mental health benefits have yet to be explored in the context of psychosis risk[272,273,280,281]. Research into the impact of the built environment is particularly scant. Furthermore, most studies have investigated the effects of single factors rather than a constellation of intersecting and multisystemic risk and protective and promotive factors. This makes it impossible to unpack the mechanisms by which these factors come to be associated with resilient outcomes—that is, whether they directly impact outcome measures, or indirectly influence outcomes via other protective, promotive, or vulnerability factors. Moreover, the reviewed factors should be considered on a continuum, whereby optimal levels are protective or promotive and sub-optimal levels confer vulnerability. For example, social support can buffer against risk whereas social isolation might create vulnerability. It is unclear whether there are shared underlying mechanisms, or whether factors operate via distinct pathways at each end of the continuum.

Third, there is little examination of contextual effects in the current psychosis resilience literature. This is a critical gap because when it comes to resilience, one size does not fit all. For example, risk context might influence the degree to which a resource or positive behavior confers benefits. Risk context refers to whether risk occurs in the preliminary circumstances that might lead to a psychotic disorder diagnosis, in distress that emerges from the symptoms themselves, or in secondary risks after diagnosis. The degree of overlap in the factors that promote resilience in the context of these different types of risk and the mechanisms by which they might do so is unclear. Many of the resilience-promoting factors reviewed here, such as positive health behaviors, adaptive coping strategies, or access to green space, reduce the likelihood of being diagnosed with a psychotic disorder. They also engender beneficial effects in

those already diagnosed, which is consistent with the fact that these factors promote mental health and well-being in the general population. Other factors, such as stigma resistance and meaning making, might only produce positive outcomes in the context of a mental health diagnosis and clinically significant psychotic experiences.

The benefits conferred by a putative protective or promotive factor might also depend on other contextual factors. Specific factors might have a more profound impact during sensitive periods of brain development characterized by higher plasticity. Notably, the timing of these critical periods are themselves malleable and changed by environmental factors[282-285]. In addition, culture is a critical contextual factor. The definition of a positive outcome and the ways in which resilience at the level of the individual is prioritized relative to other levels of the social ecology are inherently culturally-dependent[286,287]. Furthermore, there are robust cultural and geopolitical differences in the clinical course of psychotic disorders that cannot be explained exclusively by diagnostic differences. For example, individuals in low-income and middle-income regions fare better following a diagnosis of schizophrenia than individuals in high-income regions[288-295]. Finally, the positive effect of engaging in positive coping strategies might be stymied when structural inequalities pose barriers to obtaining basic needs[89]. Indeed, the RAISE-ETP study showed that treatment based on a coordinated specialty care intervention for early psychosis that adopts a strengths and resilience based approach only improved symptoms and quality of life in individuals at the top 25% of the socioeconomic distribution[296, 297].

Finally, the bulk of research to date on resilience factors for psychosis has focused somewhat narrowly on clinical outcomes such as diagnosis and relapse, with resilience in non-clinical domains remaining largely unaddressed. Relatedly, conceptual models of resilient outcomes that guide current research might not necessarily align with those of individuals with lived experience of psychosis.

[H1] Summary and future directions

Resilience models stand to enhance, refine, and complement what has been learned from traditional risk-based approaches to psychosis. Moreover, understanding modifiable factors that lead to resilience in the face of psychosis risk will be central to therapeutic innovation. Existing research highlights several promising modifiable protective and promotive factors in the context of psychosis risk, including health behaviors, psychological strengths, attitudes, and abilities, social interactions, support, and cohesion, and access to green space. Future research must now bridge the critical gaps we identified in the current literature.

First, future research should test a comprehensive set of (ideally modifiable) potential protective and promotive factors to identify factors with the strongest associations with positive outcomes both individually and when considered in concert with other factors. Relatedly, future work should test whether putative associations are moderated by psychosis risk, which would distinguish protective from promotive factors. Such research can then be used to identify promising targets for novel and cost-effective interventions. Identifying promotive factors could support the implementation of broad, public health-informed strategies to shore up factors that increase positive outcomes for emerging adults in general[298]. Identifying protective factors could inform clinical staging interventions that acknowledge the ‘pluripotential’ nature of psychosis risk[299-302], whereby the identified individuals are at heightened risk for a variety of psychiatric outcomes. Indeed, an increasing number of clinical high-risk research groups are moving toward transdiagnostic clinical staging approaches that focus on youth mental health more generally[299-302]. In addition, future work should examine the co-occurring influences that might moderate the impact of protective and promotive factors. Knowing what factors are associated with positive outcomes, when, and for whom, is central to understanding at what level of a

biopsychosocial-ecological system resilience-promoting assets and activities yield better individual-level outcomes, to developing tailored interventions, and to understanding heterogeneity in outcomes.

Second, future research should re-imagine positive outcomes to be broader than the mere absence of psychological distress and diagnosis. Resilient outcomes are multifaceted, and future work in this field would benefit from considering a wider range of measures that include academic performance, work outcomes, physical health, social functioning, and purpose in addition to mental health. Furthermore, researchers should consider positive outcomes at broader levels of the social ecology and the ensuing impact on individual outcomes—for example, how individual activism might promote transformation of social institutions that in turn engenders more rights and opportunities for those living with mental illness.

Third, given the inherent multisystemic nature of resilience, diverse teams that include multidisciplinary scholars as well as individuals who have traditionally been excluded from academic discourse will be critical for gaining a broader perspective on potential protective and promotive factors and on defining positive outcomes. This includes individuals with lived experience of psychosis, families, teachers, and community and religious leaders who often encounter people experiencing or at-risk for mental health emergencies along their pathway to care. Furthermore, more cross-cultural work is needed, as positive outcomes and resilience promoting processes are inherently shaped by culture. Looking beyond the biomedical models of mental health that have dominated scientific discourse might allow us to reshape or refine our conceptualization of positive outcomes, which could potentially uncover additional resilience-promoting factors.

Finally, several methodological considerations will likely enhance the study of resilience to psychosis risk. First, mixed methods approaches that link qualitative and quantitative research can provide a springboard for generating testable hypotheses regarding factors that might confer protection against psychotic symptoms and related distress. Second, resilience is best represented as a positive trajectory and therefore not fully captured by a single moment in time[303].Thus, longitudinal studies are critical for characterizing this trajectory and determining causal relationships between factors and outcomes, particularly as compromised access to and engagement in the promotive and protective factors might be direct consequences of illness. Indeed, prospective longitudinal studies have provided critical data regarding factors that contribute to the development of a psychotic disorder and poor clinical outcomes among high-risk individuals[304-307]. Third, more is not always better, and researchers should consider non-linear relationships between outcome metrics and both risk and protective and promotive factors. For example, stress is typically considered a risk factor, but might have inoculating effects in small doses [308]. Fourth, natural and passive monitoring approaches, such as ecological momentary assessment and mobility tracking can greatly enhance ecological validity and provide richer assessments that capture the complexity of participants' daily lives[309]. For example, geospatial location and geographical information systems can objectively measure how often and for how long people are exposed to natural or built features of the environment, and how these durations relate to mental health[261,310,311]. Finally, it is paramount to expand beyond help-seeking samples. Individuals identified at clinical high-risk are already experiencing significant clinical distress related to attenuated psychotic symptoms, social and functioning difficulties, depression, and other sources[312]. Identifying individuals in the general population who are at-risk for psychosis owing to attenuated psychotic symptoms or genetic risk but who do not present with a need for care might provide insights into factors that help avert the functional decline that leads young people at-risk for psychosis to seek help in the first place.

In conclusion, our Review suggests that the ‘ordinary magic’[313] that constitutes human resilience promotes positive adaptations in what is generally considered to be the most severe of mental health conditions[314]. Such findings are particularly important given antiquated, but still influential, notions of schizophrenia as a progressively deteriorating illness[315] with its basis in irreversible etiological factors that manifest later in life[316]. The factors reviewed here are modifiable, thereby reinforcing the notion that illness course can be changed. The identified modifiable resilience factors provide valuable data that can inform therapeutic development, including individual prevention and intervention efforts, institutional programs, and broader policy.

711
712 References
713

714 1 Laursen, T. M., Nordentoft, M. & Mortensen, P. B. Excess early mortality in
715 schizophrenia. *Annu Rev Clin Psychol* **10**, 425-448 (2014).
716 2 Selten, J. P. *et al.* Early course of schizophrenia in a representative Dutch incidence
717 cohort. *Schizophr. Res.* **97**, 79-87 (2007).
718 3 Levesque, I. S. & Abdel-Baki, A. Homeless youth with first-episode psychosis: A 2-year
719 outcome study. *Schizophr. Res.* **216**, 460-469 (2020).
720 4 Melle, I., Friis, S., Hauff, E. & Vaglum, P. Social functioning of patients with
721 schizophrenia in high-income welfare societies. *Psychiatr. Serv.* **51**, 223-228 (2000).
722 5 Honkonen, T., Saarinen, S. & Salokangas, R. K. Deinstitutionalization and schizophrenia
723 in Finland II: discharged patients and their psychosocial functioning. *Schizophr. Bull.* **25**,
724 543-551 (1999).
725 6 Ran, M. S. *et al.* Homelessness among patients with schizophrenia in rural China: a 10-
726 year cohort study. *Acta Psychiatr. Scand.* **114**, 118-123 (2006).
727 7 Gureje, O. & Bamidele, R. Thirteen-year social outcome among Nigerian outpatients
728 with schizophrenia. *Soc. Psychiatry Psychiatr. Epidemiol.* **34**, 147-151 (1999).
729 8 Folsom, D. P. *et al.* Prevalence and risk factors for homelessness and utilization of
730 mental health services among 10,340 patients with serious mental illness in a large
731 public mental health system. *Am. J. Psychiatry* **162**, 370-376 (2005).
732 9 Pinikahana, J., Happell, B., Hope, J. & Keks, N. A. Quality of life in schizophrenia: a
733 review of the literature from 1995 to 2000. *Int J Ment Health Nurs* **11**, 103-111 (2002).
734 10 Lieberman, J. A. *et al.* Science and recovery in schizophrenia. *Psychiatr. Serv.* **59**, 487-
735 496 (2008).
736 11 Correll, C. U. *et al.* Comparison of Early Intervention Services vs Treatment as Usual for
737 Early-Phase Psychosis: A Systematic Review, Meta-analysis, and Meta-regression.
738 *JAMA Psychiatry* **75**, 555-565 (2018).
739 12 Yung, A. R. *et al.* Mapping the onset of psychosis: the Comprehensive Assessment of
740 At-Risk Mental States. *Aust. N. Z. J. Psychiatry* **39**, 964-971 (2005).
741 13 Fusar-Poli, P. *et al.* Prevention of Psychosis: Advances in Detection, Prognosis, and
742 Intervention. *JAMA Psychiatry* **77**, 755-765 (2020).
743 14 Fusar-Poli, P. *et al.* Predicting psychosis: meta-analysis of transition outcomes in
744 individuals at high clinical risk. *Arch. Gen. Psychiatry* **69**, 220-229 (2012).
745 15 Fusar-Poli, P. *et al.* Real-world long-term outcomes in individuals at clinical risk for
746 psychosis: The case for extending duration of care. *EClinicalMedicine* **28**, 100578
747 (2020).
748 16 Salazar de Pablo, G. *et al.* Longitudinal outcome of attenuated positive symptoms,
749 negative symptoms, functioning and remission in people at clinical high risk for
750 psychosis: a meta-analysis. *EClinicalMedicine* **36**, 100909 (2021).
751 17 Haro, J. M. *et al.* Cross-national clinical and functional remission rates: Worldwide
752 Schizophrenia Outpatient Health Outcomes (W-SOHO) study. *Br. J. Psychiatry* **199**,
753 194-201 (2011).
754 **This paper reports rates of clinical and functional remission in over 10,000**
755 **outpatients diagnosed with schizophrenia across the world.**
756 18 Lally, J. *et al.* Remission and recovery from first-episode psychosis in adults: systematic
757 review and meta-analysis of long-term outcome studies. *Br. J. Psychiatry* **211**, 350-358
758 (2017).
759 19 Rangaswamy, T. Twenty-five years of schizophrenia: The Madras longitudinal study.
760 *Indian J Psychiatry* **54**, 134-137 (2012).

761 20 Jobe , T. H. & Harrow , M. Schizophrenia Course, Long-Term Outcome, Recovery, and Prognosis. *Current Directions in Psychological Science* **19**, 220-225 (2010).
763 21 Volavka, J. & Vevera, J. Very long-term outcome of schizophrenia. *Int. J. Clin. Pract.* **72**, e13094 (2018).
765 22 Masten, A. S., Lucke, C. M., Nelson, K. M. & Stallworthy, I. C. Resilience in Development and Psychopathology: Multisystem Perspectives. *Annu Rev Clin Psychol* **17**, 521-549 (2021).
768 **This article describes the history of resilience science in psychology and provides current definitions and an overview of updated resilience models.**
770 23 Carpenter, W. T., Jr. Schizophrenia: A view of immediate future. *Schizophr. Res.* (2021).
772 24 Andreasen, N. C. Understanding the causes of schizophrenia. *N. Engl. J. Med.* **340**, 645-647 (1999).
774 25 Bleuler, M. Conception of Schizophrenia Within the Last Fifty Years and Today [Abridged]. *Proc. R. Soc. Med.* **56**, 945-952 (1963).
776 26 Rosenthal, D. *The Genain Quadruplets: A Case Study and Theoretical Analysis of Heredity and Environment in Schizophrenia*. (Basic Books, 1963).
778 27 Hilker, R. *et al.* Heritability of Schizophrenia and Schizophrenia Spectrum Based on the Nationwide Danish Twin Register. *Biol. Psychiatry* **83**, 492-498 (2018).
780 28 Rasic, D., Hajek, T., Alda, M. & Uher, R. Risk of mental illness in offspring of parents with schizophrenia, bipolar disorder, and major depressive disorder: a meta-analysis of family high-risk studies. *Schizophr. Bull.* **40**, 28-38 (2014).
783 29 Singh, T. *et al.* Rare coding variants in ten genes confer substantial risk for schizophrenia. *Nature* **604**, 509-516 (2022).
785 30 Trubetskoy, V. *et al.* Mapping genomic loci implicates genes and synaptic biology in schizophrenia. *Nature* **604**, 502-508 (2022).
787 31 Davies, C. *et al.* Prenatal and perinatal risk and protective factors for psychosis: a systematic review and meta-analysis. *Lancet Psychiatry* **7**, 399-410 (2020).
789 **This is a meta-analysis of 152 studies showing several prenatal and perinatal factors that are associated with the later onset of psychosis.**
791 32 Radua, J. *et al.* What causes psychosis? An umbrella review of risk and protective factors. *World Psychiatry* **17**, 49-66 (2018).
793 **This paper summarizes results of systematic reviews and meta-analyses, and classifies risk and protective factors according to the strength of evidence.**
795 33 Linszen, M. M., Brouwer, R. M., Heringa, S. M. & Sommer, I. E. Increased risk of psychosis in patients with hearing impairment: Review and meta-analyses. *Neurosci. Biobehav. Rev.* **62**, 1-20 (2016).
798 34 de Sousa, P., Varese, F., Sellwood, W. & Bentall, R. P. Parental communication and psychosis: a meta-analysis. *Schizophr. Bull.* **40**, 756-768 (2014).
800 35 Filatova, S. *et al.* Early motor developmental milestones and schizophrenia: A systematic review and meta-analysis. *Schizophr. Res.* **188**, 13-20 (2017).
802 36 Matheson, S. L., Shepherd, A. M., Laurens, K. R. & Carr, V. J. A systematic meta-review grading the evidence for non-genetic risk factors and putative antecedents of schizophrenia. *Schizophr. Res.* **133**, 133-142 (2011).
805 37 Dean, K. & Murray, R. M. Environmental risk factors for psychosis. *Dialogues Clin Neurosci* **7**, 69-80 (2005).
807 38 Loewy, R. L. *et al.* Childhood trauma and clinical high risk for psychosis. *Schizophr. Res.* **205**, 10-14 (2019).
809 39 Varese, F. *et al.* Childhood adversities increase the risk of psychosis: a meta-analysis of patient-control, prospective- and cross-sectional cohort studies. *Schizophr. Bull.* **38**, 661-671 (2012).

40 Beards, S. *et al.* Life events and psychosis: a review and meta-analysis. *Schizophr. Bull.* **39**, 740-747 (2013).

41 Lopez, D., Altamirano, O. & Weisman de Mamani, A. The association between perceived racial discrimination and subclinical symptoms of psychosis. *J Ment Health* **31**, 14-21 (2022).

42 Bardol, O. *et al.* Perceived ethnic discrimination as a risk factor for psychotic symptoms: a systematic review and meta-analysis. *Psychol. Med.* **50**, 1077-1089 (2020).

43 Post, D., Veling, W. & investigators, G. Sexual minority status, social adversity and risk for psychotic disorders-results from the GROUP study. *Psychol. Med.* **51**, 770-776 (2021).

44 Anglin, D. M. *et al.* From Womb to Neighborhood: A Racial Analysis of Social Determinants of Psychosis in the United States. *Am. J. Psychiatry* **178**, 599-610 (2021).

45 Vassos, E., Pedersen, C. B., Murray, R. M., Collier, D. A. & Lewis, C. M. Meta-analysis of the association of urbanicity with schizophrenia. *Schizophr. Bull.* **38**, 1118-1123 (2012).

46 Myin-Germeys, I. & van Os, J. Stress-reactivity in psychosis: evidence for an affective pathway to psychosis. *Clin. Psychol. Rev.* **27**, 409-424 (2007).

47 Collip, D., Myin-Germeys, I. & Van Os, J. Does the concept of "sensitization" provide a plausible mechanism for the putative link between the environment and schizophrenia? *Schizophr. Bull.* **34**, 220-225 (2008).

48 Holtzman, C. W. *et al.* Stress and neurodevelopmental processes in the emergence of psychosis. *Neuroscience* **249**, 172-191 (2013).

49 U.S. Department of Health and Human Services, N. I. o. H., National Institute of Mental Health. *NIMH Strategic Plan for Research (NIH Publication No. 20-MH-8096).* <https://www.nimh.nih.gov/sites/default/files/documents/about/strategic-planning-reports/NIMH-Strategic-Plan-for-Research-2021-Update.pdf> (Updated 2021).

50 Riechler-Rossler, A. & McGorry, P. D. *Early detection and intervention in psychosis: state of the art and future perspectives*. (Karger, 2016).

51 Cannon, T. D. *et al.* An Individualized Risk Calculator for Research in Prodromal Psychosis. *Am. J. Psychiatry* **173**, 980-988 (2016).
This paper reports the accuracy of a calculator developed to compute risk for developing a psychotic disorder in individuals formally categorized as clinical high-risk cases.

52 Studerus, E., Beck, K., Fusar-Poli, P. & Riecher-Rössler, A. Development and Validation of a Dynamic Risk Prediction Model to Forecast Psychosis Onset in Patients at Clinical High Risk. *Schizophr. Bull.* **46**, 252-260 (2020).

53 Perkins, D. O., Gu, H., Boteva, K. & Lieberman, J. A. Relationship between duration of untreated psychosis and outcome in first-episode schizophrenia: a critical review and meta-analysis. *Am. J. Psychiatry* **162**, 1785-1804 (2005).

54 Howes, O. D. *et al.* The clinical significance of duration of untreated psychosis: an umbrella review and random-effects meta-analysis. *World Psychiatry* **20**, 75-95 (2021).

55 Jonas, K. G. *et al.* Lead-Time Bias Confounds Association Between Duration of Untreated Psychosis and Illness Course in Schizophrenia. *Am. J. Psychiatry* **177**, 327-334 (2020).

56 van Os, J. & Guloksuz, S. A critique of the "ultra-high risk" and "transition" paradigm. *World Psychiatry* **16**, 200-206 (2017).

57 Rogers, R. The uncritical acceptance of risk assessment in forensic practice. *Law Hum. Behav.* **24**, 595-605 (2000).

58 Salazar de Pablo, G. *et al.* Probability of Transition to Psychosis in Individuals at Clinical High Risk: An Updated Meta-analysis. *JAMA Psychiatry* **78**, 970-978 (2021).

59 Addington, J. *et al.* North American Prodrome Longitudinal Study (NAPLS 2): The Prodromal Symptoms. *J. Nerv. Ment. Dis.* **203**, 328-335 (2015).

60 Simon, A. E. *et al.* Moving beyond transition outcomes: meta-analysis of remission rates in individuals at high clinical risk for psychosis. *Psychiatry Res.* **209**, 266-272 (2013).

61 Sullivan, S. A. *et al.* A Population-Based Cohort Study Examining the Incidence and Impact of Psychotic Experiences From Childhood to Adulthood, and Prediction of Psychotic Disorder. *Am. J. Psychiatry* **177**, 308-317 (2020).

62 Kaymaz, N. *et al.* Do subthreshold psychotic experiences predict clinical outcomes in unselected non-help-seeking population-based samples? A systematic review and meta-analysis, enriched with new results. *Psychol. Med.* **42**, 2239-2253 (2012). **This systematic review and meta-analysis reports the base rate of transition from subthreshold psychotic experiences to psychotic disorder diagnosis in representative and non-help-seeking population-based samples.**

63 Yung, A. R. *et al.* Validation of "prodromal" criteria to detect individuals at ultra high risk of psychosis: 2 year follow-up. *Schizophr. Res.* **105**, 10-17 (2008).

64 Haroun, N., Dunn, L., Haroun, A. & Cadenhead, K. S. Risk and protection in prodromal schizophrenia: ethical implications for clinical practice and future research. *Schizophr. Bull.* **32**, 166-178 (2006).

65 Simon, A. E. *et al.* Ultra high-risk state for psychosis and non-transition: a systematic review. *Schizophr. Res.* **132**, 8-17 (2011).

66 Nelson, B. *et al.* Long-term follow-up of a group at ultra high risk ("prodromal") for psychosis: the PACE 400 study. *JAMA Psychiatry* **70**, 793-802 (2013).

67 Hartmann, J. A. *et al.* Declining transition rates to psychotic disorder in "ultra-high risk" clients: Investigation of a dilution effect. *Schizophr. Res.* **170**, 130-136 (2016).

68 Davies, C. *et al.* Lack of evidence to favor specific preventive interventions in psychosis: a network meta-analysis. *World Psychiatry* **17**, 196-209 (2018).

69 Pescosolido, B. A., Halpern-Manners, A., Luo, L. & Perry, B. Trends in Public Stigma of Mental Illness in the US, 1996-2018. *JAMA Netw Open* **4**, e2140202 (2021).

70 Pescosolido, B. A., Medina, T. R., Martin, J. K. & Long, J. S. The "backbone" of stigma: identifying the global core of public prejudice associated with mental illness. *Am. J. Public Health* **103**, 853-860 (2013).

71 Dubreucq, J., Plasse, J. & Franck, N. Self-stigma in Serious Mental Illness: A Systematic Review of Frequency, Correlates, and Consequences. *Schizophr. Bull.* **47**, 1261-1287 (2021).

72 Anglin, D. M., Greenspoon, M. I., Lighty, Q., Corcoran, C. M. & Yang, L. H. Spontaneous labelling and stigma associated with clinical characteristics of peers 'at-risk' for psychosis. *Early Interv Psychiatry* **8**, 247-252 (2014).

73 Yang, L. H. *et al.* Public stigma associated with psychosis risk syndrome in a college population: implications for peer intervention. *Psychiatr. Serv.* **64**, 284-288 (2013).

74 Yang, L. H. *et al.* Stigma related to labels and symptoms in individuals at clinical high-risk for psychosis. *Schizophr. Res.* **168**, 9-15 (2015).

75 Xu, Z. *et al.* Pathways between stigma and suicidal ideation among people at risk of psychosis. *Schizophr. Res.* **172**, 184-188 (2016).

76 Belsky, J., Bakermans-Kranenburg, M. J. & van IJzendoorn, M. H. For Better and For Worse: Differential Susceptibility to Environmental Influences. *Current Directions in Psychological Science* **16**, 300-304 (2007).

77 Albott, C. S., Forbes, M. K. & Anker, J. J. Association of Childhood Adversity With Differential Susceptibility of Transdiagnostic Psychopathology to Environmental Stress in Adulthood. *JAMA Netw Open* **1**, e185354 (2018).

78 Ferrarelli, F. & Mathalon, D. The prodromal phase: Time to broaden the scope beyond transition to psychosis? *Schizophr. Res.* **216**, 5-6 (2020).

913 79 Polari, A. *et al.* Clinical trajectories in the ultra-high risk for psychosis population. *Schizophr. Res.* **197**, 550-556 (2018).
915 80 Ungar, M. *Modeling Multisystemic Resilience*. (Oxford University Press, 2021).
916 81 Luthar, S. S., Cicchetti, D. & Becker, B. The construct of resilience: a critical evaluation and guidelines for future work. *Child Dev.* **71**, 543-562 (2000).
918 82 Bronfenbrenner, U. *Making human beings human: Bioecological perspectives on human development*. (Sage Publications Ltd, 2005).
920 83 Ungar, M. & Theron, L. Resilience and mental health: how multisystemic processes contribute to positive outcomes. *Lancet Psychiatry* **7**, 441-448 (2020).
922 **This paper provides an overview of the concept of resilience as the process of multiple systems interacting in ways that promote wellbeing in the context of risk factors.**
925 84 Baumeister, D., Sedgwick, O., Howes, O. & Peters, E. Auditory verbal hallucinations and continuum models of psychosis: A systematic review of the healthy voice-hearer literature. *Clin. Psychol. Rev.* **51**, 125-141 (2017).
928 85 Rose, D. *et al.* Reported stigma and discrimination by people with a diagnosis of schizophrenia. *Epidemiol Psychiatr Sci* **20**, 193-204 (2011).
930 86 Marder, S. R. *et al.* Physical health monitoring of patients with schizophrenia. *Am. J. Psychiatry* **161**, 1334-1349 (2004).
932 87 Rutter, M. Psychosocial Resilience and Protective Mechanisms. *Am. J. Orthopsychiatry* **57,** 316-331(1987).
934 **This is a seminal theory paper on human resilience that provides clear conceptual distinctions between vulnerability and protective factor.**
936 88 Rutter, M. Transitions and Turning Points in Developmental Psychopathology: As applied to the Age Span between Childhood and Mid-adulthood. *International Journal of Behavioral Development* **19**, 603-626 (1996).
939 89 Miller-Graff, L. E. The Multidimensional Taxonomy of Individual Resilience. *Trauma Violence Abuse*, 1524838020967329 (2020).
941 **This is a narrative overview of resilience science, including challenges faced by theoretical models of human resilience, which also proposes a framework for organizing and advancing research in resilience.**
944 90 Burt, S. A., Klump, K. L., Vazquez, A. Y., Shewark, E. A. & Hyde, L. W. Identifying Patterns of Youth Resilience to Neighborhood Disadvantage. *Res Hum Dev* **18**, 181-196 (2021).
947 **This paper reveals three partly independent domains of resilient outcomes in youth exposed to neighborhood disadvantage, highlighting the heterogenous nature of positive outcomes.**
950 91 Cohen, C. I. *et al.* Focus on geriatric psychiatry: schizophrenia in later life: clinical symptoms and social well-being. *Psychiatr. Serv.* **59**, 232-234 (2008).
952 92 Antaramian, S. P., Scott Huebner, E., Hills, K. J. & Valois, R. F. A dual-factor model of mental health: toward a more comprehensive understanding of youth functioning. *Am. J. Orthopsychiatry* **80**, 462-472 (2010).
955 93 Infurna, F. J. & Luthar, S. S. Parents' adjustment following the death of their child: Resilience is multidimensional and differs across outcomes examined. *J Res Pers* **68**, 38-53 (2017).
958 94 Martinez-Torteya, C., Miller-Graff, L. E., Howell, K. H. & Figge, C. Profiles of Adaptation Among Child Victims of Suspected Maltreatment. *J Clin Child Adolesc Psychol* **46**, 840-847 (2017).
961 95 Bonanno, G. A. Uses and abuses of the resilience construct: loss, trauma, and health-related adversities. *Soc. Sci. Med.* **74**, 753-756 (2012).

96 Grych, J., Hamby, S. & Banyard, V. The resilience portfolio model: Understanding healthy adaptation in victims of violence. *Psychology of Violence* **5**, 343–354 (2015).

97 Mahdiani, H. & Ungar, M. The Dark Side of Reslience. *Adversity and Resilience Science* **2**, 147-155 (2021).

98 Andresen, R., Oades, L. & Caputi, P. The experience of recovery from schizophrenia: towards an empirically validated stage model. *Aust. N. Z. J. Psychiatry* **37**, 586-594 (2003).

99 Shinn, A. K. *et al.* Return to College After a First Episode of Psychosis. *Schizophr Bull Open* **1**, sgaa041 (2020).

100 Law, H. & Morrison, A. P. Recovery in psychosis: a Delphi study with experts by experience. *Schizophr. Bull.* **40**, 1347-1355 (2014).

This article identifies consensus among definitions of recovery in a large sample of service users with a history of psychosis.

101 Fusar-Poli, P. *et al.* The lived experience of psychosis: a bottom-up review co-written by experts by experience and academics. *World Psychiatry* **21**, 168-188 (2022).

102 Jordan, G. *et al.* Positive Changes Experienced After a First Episode of Psychosis: A Systematic Review. *Psychiatr. Serv.* **69**, 84-99 (2018).

103 Valiente, C., Espinosa, R., Trucharte, A., Nieto, J. & Martínez-Prado, L. The challenge of well-being and quality of life: A meta-analysis of psychological interventions in schizophrenia. *Schizophr. Res.* **208**, 16-24 (2019).

104 Connell, J., O'Cathain, A. & Brazier, J. Measuring quality of life in mental health: are we asking the right questions? *Soc. Sci. Med.* **120**, 12-20 (2014).

105 Oliver, D. *et al.* What Causes the Onset of Psychosis in Individuals at Clinical High Risk? A Meta-analysis of Risk and Protective Factors. *Schizophr. Bull.* **46**, 110-120 (2020).

106 Solmi, M. *et al.* Risk and protective factors for mental disorders with onset in childhood/adolescence: An umbrella review of published meta-analyses of observational longitudinal studies. *Neurosci. Biobehav. Rev.* **120**, 565-573 (2021).

107 Sommer, I. E. *et al.* Healthy individuals with auditory verbal hallucinations; who are they? Psychiatric assessments of a selected sample of 103 subjects. *Schizophr. Bull.* **36**, 633-641 (2010).

108 Vargas, T. *et al.* Neuroimaging Markers of Resiliency in Youth at Clinical High Risk for Psychosis: A Qualitative Review. *Biol Psychiatry Cogn Neurosci Neuroimaging* **6**, 166-177 (2021).

109 Holz, N. E., Tost, H. & Meyer-Lindenberg, A. Resilience and the brain: a key role for regulatory circuits linked to social stress and support. *Mol. Psychiatry* **25**, 379-396 (2020).

110 Alvaro, P. K., Roberts, R. M. & Harris, J. K. A Systematic Review Assessing Bidirectionality between Sleep Disturbances, Anxiety, and Depression. *Sleep* **36**, 1059-1068 (2013).

111 Buysse, D. J. *et al.* Prevalence, course, and comorbidity of insomnia and depression in young adults. *Sleep* **31**, 473-480 (2008).

112 Freeman, D. *et al.* The effects of improving sleep on mental health (OASIS): a randomised controlled trial with mediation analysis. *Lancet Psychiatry* **4**, 749-758 (2017).

This papers provides evidence that cognitive behavioral therapy for insomnia improves sleep as well as paranoia and hallucinatory experiences in a large sample of university students.

113 Waters, F., Chiu, V., Atkinson, A. & Blom, J. D. Severe Sleep Deprivation Causes Hallucinations and a Gradual Progression Toward Psychosis With Increasing Time Awake. *Front Psychiatry* **9**, 303 (2018).

1013 114 Haack, M. & Mullington, J. M. Sustained sleep restriction reduces emotional and
1014 physical well-being. *Pain* **119**, 56-64 (2005).
1015 115 Zhai, L., Zhang, H. & Zhang, D. Sleep duration and depression among adults: a meta-
1016 analysis of prospective studies. *Depress. Anxiety* **32**, 664-670 (2015).
1017 116 Rebar, A. L. *et al.* A meta-meta-analysis of the effect of physical activity on depression
1018 and anxiety in non-clinical adult populations. *Health Psychol Rev* **9**, 366-378 (2015).
1019 117 Rodriguez-Ayllon, M. *et al.* Role of Physical Activity and Sedentary Behavior in the
1020 Mental Health of Preschoolers, Children and Adolescents: A Systematic Review and
1021 Meta-Analysis. *Sports Med.* **49**, 1383-1410 (2019).
1022 118 Spence, J. C., McGannon, K. R. & Poon, P. The effect of exercise on global self-esteem:
1023 A quantitative review. *Journal of sport and exercise psychology* **27**, 311-334 (2005).
1024 119 Mammen, G. & Faulkner, G. Physical activity and the prevention of depression: a
1025 systematic review of prospective studies. *Am. J. Prev. Med.* **45**, 649-657 (2013).
1026 120 Teychenne, M., Ball, K. & Salmon, J. Physical activity and likelihood of depression in
1027 adults: a review. *Prev. Med.* **46**, 397-411 (2008).
1028 121 Teychenne, M. *et al.* Do we need physical activity guidelines for mental health: What
1029 does the evidence tell us? . *Mental Health and Physical Activity* **18**, 100315 (2020).
1030 122 World Health Organization. *WHO Guidelines on Physical Activity and Sedentary
1031 Behavior*. (2020).
1032 123 Neill, R. D., Lloyd, K., Best, P. & Tully, M. A. The effects of interventions with physical
1033 activity components on adolescent mental health: Systematic review and meta-analysis.
1034 *Mental Health and Physical Activity* **19** (2020).
1035 124 Crush, E. *et al.* Protective factors for psychotic experiences amongst adolescents
1036 exposed to multiple forms of victimization. *J. Psychiatr. Res.* **104**, 32-38 (2018).
1037 125 Sormunen, E. *et al.* Effects of childhood and adolescence physical activity patterns on
1038 psychosis risk-a general population cohort study. *NPJ Schizophr* **3**, 5 (2017).
1039 **This population-based cohort study found that higher levels of physical activity in
1040 childhood and adolescence were associated with a lower risk of developing a non-
1041 affective psychotic disorder.**
1042 126 Koivukangas, J. *et al.* Physical activity and fitness in adolescents at risk for psychosis
1043 within the Northern Finland 1986 Birth Cohort. *Schizophr. Res.* **116**, 152-158 (2010).
1044 127 Ohi, K. *et al.* Meta-analysis of physical activity and effects of social function and quality
1045 of life on the physical activity in patients with schizophrenia. *Eur. Arch. Psychiatry Clin.
1046 Neurosci.* **269**, 517-527 (2019).
1047 128 Holley, J., Crone, D., Tyson, P. & Lovell, G. The effects of physical activity on
1048 psychological well-being for those with schizophrenia: A systematic review. *Br. J. Clin.
1049 Psychol.* **50**, 84-105 (2011).
1050 129 Rosenbaum, S., Tiedemann, A., Sherrington, C., Curtis, J. & Ward, P. B. Physical
1051 activity interventions for people with mental illness: a systematic review and meta-
1052 analysis. *J. Clin. Psychiatry* **75**, 964-974 (2014).
1053 130 Mittal, V. A. *et al.* Exercise Treatments for Psychosis: A Review. *Curr Treat Options
1054 Psychiatry* **4**, 152-166 (2017).
1055 131 Firth, J. *et al.* Aerobic Exercise Improves Cognitive Functioning in People With
1056 Schizophrenia: A Systematic Review and Meta-Analysis. *Schizophr. Bull.* **43**, 546-556
1057 (2017).
1058 132 McMahon, E. M. *et al.* Risk and protective factors for psychotic experiences in
1059 adolescence: a population-based study. *Psychol. Med.* **51**, 1220-1228 (2021).
1060 133 Perna, G. *et al.* Heart rate variability: Can it serve as a marker of mental health
1061 resilience?: Special Section on "Translational and Neuroscience Studies in Affective
1062 Disorders" Section Editor, Maria Nobile MD, PhD. *J. Affect. Disord.* **263**, 754-761
1063 (2020).

1064 134 An, E. *et al.* Heart Rate Variability as an Index of Resilience. *Mil. Med.* **185**, 363-369 (2020).
1065
1066 135 Williams, D. P. *et al.* Resting heart rate variability predicts self-reported difficulties in
1067 emotion regulation: a focus on different facets of emotion regulation. *Front Psychol* **6**,
1068 261 (2015).
1069 136 Thayer, J. F., Hansen, A. L., Saus-Rose, E. & Johnsen, B. H. Heart rate variability,
1070 prefrontal neural function, and cognitive performance: the neurovisceral integration
1071 perspective on self-regulation, adaptation, and health. *nn. Behav. Med.* **37**, 141-153
1072 (2009).
1073 137 Thayer, J. F. & Lane, R. D. Claude Bernard and the heart-brain connection: further
1074 elaboration of a model of neurovisceral integration. *Neurosci. Biobehav. Rev.* **33**, 81-88
1075 (2009).
1076 138 Beauchaine, T. P. Respiratory Sinus Arrhythmia: A Transdiagnostic Biomarker of
1077 Emotion Dysregulation and Psychopathology. *Curr Opin Psychol* **3**, 43-47 (2015).
1078 139 Cacciotti-Saija, C., Quintana, D. S., Alvares, G. A., Hickie, I. B. & Guastella, A. J.
1079 Reduced heart rate variability in a treatment-seeking early psychosis sample. *Psychiatry*
1080 *Res.* **269**, 293-300 (2018).
1081 140 Clamor, A., Lincoln, T. M., Thayer, J. F. & Koenig, J. Resting vagal activity in
1082 schizophrenia: meta-analysis of heart rate variability as a potential endophenotype. *Br.*
1083 *J. Psychiatry* **208**, 9-16 (2016).
1084 141 Zhang, T. H. *et al.* Imbalance Model of Heart Rate Variability and Pulse Wave Velocity in
1085 Psychotic and Nonpsychotic Disorders. *Schizophr. Bull.* **48**, 154-165 (2022).
1086 142 Benjamin, B. R. *et al.* Heart rate variability is associated with disease severity in
1087 psychosis spectrum disorders. *Prog. Neuropsychopharmacol. Bol. Psychiatry* **111**,
1088 110108 (2021).
1089 143 Haigh, S. M., Walford, T. P. & Brosseau, P. Heart Rate Variability in Schizophrenia and
1090 Autism. *Front Psychiatry* **12**, 760396 (2021).
1091 144 Clamor, A., Ludwig, L. & Lincoln, T. M. Heart rate variability as an index of emotion
1092 (dys)regulation in psychosis? *Int. J. Psychophysiol.* **158**, 310-317 (2020).
1093 145 Hamilton, H. K. *et al.* Social cognition and functional outcome in schizophrenia: The
1094 moderating role of cardiac vagal tone. *J. Abnorm. Psychol.* **123**, 764-770 (2014).
1095 146 Mathewson, K. J., Jetha, M. K., Goldberg, J. O. & Schmidt, L. A. Autonomic regulation
1096 predicts performance on Wisconsin Card Sorting Test (WCST) in adults with
1097 schizophrenia. *Biol. Psychol.* **91**, 389-399 (2012).
1098 147 Lehrer, P. M. & Gevirtz, R. Heart rate variability biofeedback: how and why does it work?
1099 *Front Psychol* **5**, 756 (2014).
1100 148 Goessl, V. C., Curtiss, J. E. & Hofmann, S. G. The effect of heart rate variability
1101 biofeedback training on stress and anxiety: a meta-analysis. *Psychol. Med.* **47**, 2578-
1102 2586 (2017).
1103 149 Sandercock, G. R., Bromley, P. D. & Brodie, D. A. Effects of exercise on heart rate
1104 variability: inferences from meta-analysis. *Med. Sci. Sports Exerc.* **37**, 433-439 (2005).
1105 150 Lehrer, P. *et al.* Heart Rate Variability Biofeedback Improves Emotional and Physical
1106 Health and Performance: A Systematic Review and Meta Analysis. *Appl. Psychophysiol.*
1107 *Biofeedback* **45**, 109-129 (2020).
1108 151 Kirk, U. & Axelsen, J. L. Heart rate variability is enhanced during mindfulness practice: A
1109 randomized controlled trial involving a 10-day online-based mindfulness intervention.
1110 *PLoS One* **15**, e0243488 (2020).
1111 152 Grässler, B., Thielmann, B., Böckelmann, I. & Hökelmann, A. Effects of Different
1112 Training Interventions on Heart Rate Variability and Cardiovascular Health and Risk
1113 Factors in Young and Middle-Aged Adults: A Systematic Review. *Front Physiol* **12**,
1114 657274 (2021).

1115 153 McAusland, L. & Addington, J. Biofeedback to treat anxiety in young people at clinical
1116 high risk for developing psychosis. *Early Interv Psychiatry* **12**, 694-701 (2018).
1117 154 Clamor, A., Koenig, J., Thayer, J. F. & Lincoln, T. M. A randomized-controlled trial of
1118 heart rate variability biofeedback for psychotic symptoms. *Behav. Res. Ther.* **87**, 207-
1119 215 (2016).
1120 155 Folkman, S. & Lazarus, R. S. An analysis of coping in a middle-aged community sample.
1121 *J. Health Soc. Behav.* **21**, 219-239 (1980).
1122 156 Lazarus, R. S. & Folkman, S. *Stress, Appraisal, and Coping*. (Springer Publishing
1123 Company, Inc., 1984).
1124 157 Lin, A. *et al.* The relationship between coping and subclinical psychotic experiences in
1125 adolescents from the general population--a longitudinal study. *Psychol. Med.* **41**, 2535-
1126 2546 (2011).
1127 158 Ered, A., Gibson, L. E., Maxwell, S. D., Cooper, S. & Ellman, L. M. Coping as a mediator
1128 of stress and psychotic-like experiences. *Eur Psychiatry* **43**, 9-13 (2017).
1129 159 Mian, L., Lattanzi, G. M. & Tognin, S. Coping strategies in individuals at ultra-high risk of
1130 psychosis: A systematic review. *Early Interv Psychiatry* **12**, 525-534 (2018).
1131 160 Ritsner, M., Gibel, A. & Ratner, Y. Determinants of changes in perceived quality of life in
1132 the course of schizophrenia. *Qual. Life Res.* **15**, 515-526 (2006).
1133 161 Boschi, S. *et al.* Coping with psychotic symptoms in the early phases of schizophrenia.
1134 *Am. J. Orthopsychiatry* **70**, 242-252 (2000).
1135 162 Cooke, M. *et al.* Insight, distress and coping styles in schizophrenia. *Schizophr. Res.* **94**,
1136 12-22 (2007).
1137 163 Rudnick, A. & Martins, J. Coping and schizophrenia: a re-analysis. *Arch. Psychiatr. Nurs.*
1138 **23**, 11-15 (2009).
1139 164 Meyer, B. Coping with severe mental illness: Relations of the brief COPE with
1140 symptoms, functioning, and well-being. *J Psychopathol Behav* **23**, 265-277 (2001).
1141 165 Jalbrzikowski, M. *et al.* Coping styles of individuals at clinical high risk for developing
1142 psychosis. *Early Interv Psychiatry* **8**, 68-76 (2014).
1143 **This prospective longitudinal study shows that more adaptive coping at baseline**
1144 **is associated with attenuated clinical symptom severity and better social**
1145 **functioning one year later in youth at high-risk for psychosis.**
1146 166 Shi, J. *et al.* The Relationship Between Big Five Personality Traits and Psychotic
1147 Experience in a Large Non-clinical Youth Sample: The Mediating Role of Emotion
1148 Regulation. *Front Psychiatry* **9**, 648 (2018).
1149 167 Osborne, K. J., Willroth, E. C., DeVylder, J. E., Mittal, V. A. & Hilimire, M. R.
1150 Investigating the association between emotion regulation and distress in adults with
1151 psychotic-like experiences. *Psychiatry Res.* **256**, 66-70 (2017).
1152 168 Sanderson, V. A. *et al.* Post-secondary students with symptoms of psychosis: A mixed-
1153 methods systematic review. *Int J Ment Health Nurs* **29**, 590-607 (2020).
1154 169 Shi, J. *et al.* Protective factors in Chinese university students at clinical high risk for
1155 psychosis. *Psychiatry Res.* **239**, 239-244 (2016).
1156 170 Wartelsteiner, F. *et al.* Quality of life in stabilized patients with schizophrenia is mainly
1157 associated with resilience and self-esteem. *Acta Psychiatr. Scand.* **134**, 360-367 (2016).
1158 171 Harris, K., Haddock, G., Peters, S. & Gooding, P. Psychological resilience to suicidal
1159 thoughts and behaviours in people with schizophrenia diagnoses : A systematic
1160 literature review. *Psychol Psychother* **93**, 777-809 (2020).
1161 172 Peters, E. *et al.* Clinical, socio-demographic and psychological characteristics in
1162 individuals with persistent psychotic experiences with and without a "need for care".
1163 *World Psychiatry* **15**, 41-52 (2016).

1164 **The results of this article provide important insights into what might reduce the**
1165 **chance of persistant psychotic experiences leading to poor psychological**
1166 **outcomes.**
1167 173 Krabbendam, L. *et al.* Neuroticism and low self-esteem as risk factors for psychosis.
1168 *Soc. Psychiatry Psychiatr. Epidemiol.* **37**, 1-6 (2002).
1169 174 Henderson, A. R. & Cock, A. The responses of young people to their experiences of
1170 first-episode psychosis: harnessing resilience. *Community Ment. Health J.* **51**, 322-328
1171 (2015).
1172 175 Ho, W. W., Chiu, M. Y., Lo, W. T. & Yiu, M. G. Recovery components as determinants of
1173 the health-related quality of life among patients with schizophrenia: structural equation
1174 modelling analysis. *Aust. N. Z. J. Psychiatry* **44**, 71-84 (2010).
1175 176 Fisher, H. L. *et al.* Pathways between childhood victimization and psychosis-like
1176 symptoms in the ALSPAC birth cohort. *Schizophr. Bull.* **39**, 1045-1055 (2013).
1177 177 Johns, L. C. *et al.* Auditory verbal hallucinations in persons with and without a need for
1178 care. *Schizophr. Bull.* **40 Suppl 4**, S255-264 (2014).
1179 178 Swyer, A. & Powers, A. R., 3rd. Voluntary control of auditory hallucinations:
1180 phenomenology to therapeutic implications. *NPJ Schizophr* **6**, 19 (2020).
1181 179 Kuranova, A. *et al.* Don't worry, be happy: Protective factors to buffer against distress
1182 associated with psychotic experiences. *Schizophr. Res.* **223**, 79-86 (2020).
1183 180 Kentros, M. K., Terkelsen, K., Hull, J., Smith, T. E. & Goodman, M. The relationship
1184 between personality and quality of life in persons with schizoaffective disorder and
1185 schizophrenia. *Qual. Life Res.* **6**, 118-122 (1997).
1186 181 Boyette, L. L. *et al.* Personality compensates for impaired quality of life and social
1187 functioning in patients with psychotic disorders who experienced traumatic events.
1188 *Schizophr. Bull.* **40**, 1356-1365 (2014).
1189 182 Ridgewell, C., Blackford, J. U., McHugo, M. & Heckers, S. Personality traits predicting
1190 quality of life and overall functioning in schizophrenia. *Schizophr. Res.* **182**, 19-23
1191 (2017).
1192 183 Corrigan, P. W. & Watson, A. C. Understanding the impact of stigma on people with
1193 mental illness. *World Psychiatry* **1**, 16-20 (2002).
1194 184 Corrigan, P. W. & Rao, D. On the self-stigma of mental illness: stages, disclosure, and
1195 strategies for change. *Can. J. Psychiatry.* **57**, 464-469 (2012).
1196 185 Yanos, P. T., Roe, D., Markus, K. & Lysaker, P. H. Pathways between internalized
1197 stigma and outcomes related to recovery in schizophrenia spectrum disorders.
1198 *Psychiatr. Serv.* **59**, 1437-1442 (2008).
1199 186 Hasson-Ohayon, I. *et al.* Between self-clarity and recovery in schizophrenia: reducing
1200 the self-stigma and finding meaning. *Compr. Psychiatry* **55**, 675-680 (2014).
1201 187 Sibitz, I., Unger, A., Woppmann, A., Zidek, T. & Amering, M. Stigma resistance in
1202 patients with schizophrenia. *Schizophr. Bull.* **37**, 316-323 (2011).
1203 188 O'Connor, L. K., Yanos, P. T. & Firmin, R. L. Correlates and moderators of stigma
1204 resistance among people with severe mental illness. *Psychiatry Res.* **270**, 198-204
1205 (2018).
1206 189 Firmin, R. L., Luther, L., Lysaker, P. H., Minor, K. S. & Salyers, M. P. Stigma resistance
1207 is positively associated with psychiatric and psychosocial outcomes: A meta-analysis.
1208 *Schizophr. Res.* **175**, 118-128 (2016).
1209 190 Rüsch, N. *et al.* Self-stigma, group identification, perceived legitimacy of discrimination
1210 and mental health service use. *Br. J. Psychiatry* **195**, 551-552 (2009).
1211 191 Yılmaz, E. & Kavak, F. Effects of Mindfulness-Based Psychoeducation on the
1212 Internalized Stigmatization Level of Patients With Schizophrenia. *Clin. Nurs. Res.* **29**,
1213 496-503 (2020).

192 Mittal, D., Sullivan, G., Chekuri, L., Allee, E. & Corrigan, P. W. Empirical Studies of Self-Stigma Reduction Strategies: A Critical Review of the Literature. *Psychiatr. Serv.* **63**, 974-981 (2012).
193 Koenig, H. G. Research on religion, spirituality, and mental health: a review. *Can. J. Psychiatry.* **54**, 283-291 (2009).
194 Migdal, L. & MacDonald, D. A. Clarifying the relation between spirituality and well-being. *J. Nerv. Ment. Dis.* **201**, 274-280 (2013).
195 Pargament, K. I. & Mahoney, A. in *Oxford handbook of positive psychology* (eds S. J. Lopez & C. R. Snyder) 611-619 (Oxford University Press., 2009).
196 Murray-Swank, A. *et al.* Correlates of religious service attendance and contact with religious leaders among persons with co-occurring serious mental illness and type 2 diabetes. *Nervous and Mental Disorders* **195**, 382-388 (2007).
197 Severaid, K. B., Osborne, K. J. & Mittal, V. A. Implications of religious and spiritual practices for youth at clinical high risk for psychosis. *Schizophr. Res.* **208**, 481-482 (2019).
198 Daalman, K. *et al.* The same or different? A phenomenological comparison of auditory verbal hallucinations in healthy and psychotic individuals. *J. Clin. Psychiatry* **72**, 320-325 (2011).
199 Moseley, P., Powell, A., Woods, A., Fernyhough, C. & Alderson-Day, B. Voice-Hearing Across The Continuum: A Phenomenology of Spiritual Voices. *Schizophr. Bull.* **48**, 1066-1074 (2022).
200 Roxburgh, E. C. & Roe, C. A. Reframing voices and visions using a spiritual model. An interpretative phenomenological analysis of anomalous experiences in mediumship. *Ment Health Relig Cult* **17**, 641-653 (2014).
201 Siddle, R., Haddock, G., Tarrier, N. & Faragher, E. B. Religious delusions in patients admitted to hospital with schizophrenia. *Soc. Psychiatry Psychiatr. Epidemiol.* **37**, 130-138 (2002).
202 Gearing, R. E. *et al.* Association of religion with delusions and hallucinations in the context of schizophrenia: implications for engagement and adherence. *Schizophr. Res.* **126**, 150-163 (2011).
203 Sariah, A. E., Outwater, A. H. & Malima, K. I. Risk and protective factors for relapse among individuals with schizophrenia: a qualitative study in Dar es Salaam, Tanzania. *BMC Psychiatry* **14**, 240 (2014).
204 Gooding, P. A., Littlewood, D., Owen, R., Johnson, J. & Tarrier, N. Psychological resilience in people experiencing schizophrenia and suicidal thoughts and behaviours. *J Ment Health* **28**, 597-603 (2019).
205 Harris, K., Gooding, P., Haddock, G. & Peters, S. Factors that contribute to psychological resilience to suicidal thoughts and behaviours in people with schizophrenia diagnoses: qualitative study. *BJPsych Open* **5**, e79 (2019).
206 Pargament, K. I. *The psychology of religion and coping: Theory, research, and practice.* (Guilford Press, 1997).
207 Koenig, H. G. *et al.* Religious coping and depression among elderly, hospitalized medically ill men. *Am. J. Psychiatry* **149**, 1693-1700 (1992).
208 Ferraro, K. F. & Koch, J. R. Religion and health among black and white adults: Examining social support and consolation. *Journal for the Scientific Study of Religion* **33**, 362-375 (1994).
209 Nguyen, A. W. Religion and Mental Health in Racial and Ethnic Minority Populations: A Review of the Literature. *Innov Aging* **4**, igaa035 (2020).
This review of research on religiosity in Black and Latino communities living in the United States highlights racial and ethnic differences in the relationship between religion and mental health outcomes.

1265 210 Heriot-Maitland, C., Knight, M. & Peters, E. A qualitative comparison of psychotic-like
1266 phenomena in clinical and non-clinical populations. *Br. J. Clin. Psychol.* **51**, 37-53
1267 (2012).
1268 211 Powers, A. R., 3rd, Kelley, M. S. & Corlett, P. R. Varieties of Voice-Hearing: Psychics
1269 and the Psychosis Continuum. *Schizophr. Bull.* **43**, 84-98 (2017).
1270 212 Lal, S. *et al.* Well-being and engagement in valued activities: experiences of young
1271 people with psychosis. *OTJR (Thorofare N J)* **33**, 190-197 (2013).
1272 213 Lal, S., Ungar, M., Malla, A., Leggo, C. & Suto, M. Impact of Mental Health Services on
1273 Resilience in Youth with First Episode Psychosis: A Qualitative Study. *Adm. Policy Ment.
1274 Health* **44**, 92-102 (2017).
1275 214 Johnson, S., Sathyaseelan, M., Charles, H., Jeyaseelan, V. & Jacob, K. S. Insight,
1276 psychopathology, explanatory models and outcome of schizophrenia in India: a
1277 prospective 5-year cohort study. *BMC Psychiatry* **12**, 159 (2012).
1278 215 Riggio, R. E. in *The sourcebook of nonverbal measures: Going beyond words* (ed V.
1279 Manusov) 25-33 (Lawrence Erlbaum Associates Publishers, 2005).
1280 216 Lecomte, T. *et al.* Predicting and preventing symptom onset and relapse in
1281 schizophrenia-A metareview of current empirical evidence. *J. Abnorm. Psychol.* **128**,
1282 840-854 (2019).
1283 217 Rossi, R. *et al.* Personal and contextual components of resilience mediate risky family
1284 environment's effect on psychotic-like experiences. *Early Interv Psychiatry* **15**, 1677-
1285 1685 (2021).
1286 218 Pan, P. M. *et al.* Childhood trauma and adolescent psychotic experiences in a
1287 community-based cohort: The potential role of positive attributes as a protective factor.
1288 *Schizophr. Res.* **205**, 23-29 (2019).
1289 219 Lam, M. *et al.* Longitudinal Cognitive Changes in Young Individuals at Ultrahigh Risk for
1290 Psychosis. *JAMA Psychiatry* **75**, 929-939 (2018).
1291 220 Fusar-Poli, P. *et al.* Cognitive functioning in prodromal psychosis: a meta-analysis. *Arch.
1292 Gen. Psychiatry* **69**, 562-571 (2012).
1293 221 De Herdt, A. *et al.* Neurocognition in clinical high risk young adults who did or did not
1294 convert to a first schizophrenic psychosis: a meta-analysis. *Schizophr. Res.* **149**, 48-55
1295 (2013).
1296 222 Hall, M. H., Holton, K. M., Öngür, D., Montrose, D. & Keshavan, M. S. Longitudinal
1297 trajectory of early functional recovery in patients with first episode psychosis. *Schizophr.
1298 Res.* **209**, 234-244 (2019).
1299 223 Crush, E., Arseneault, L., Jaffee, S. R., Danese, A. & Fisher, H. L. Protective Factors for
1300 Psychotic Symptoms Among Poly-victimized Children. *Schizophr. Bull.* **44**, 691-700
1301 (2018).
1302 **This prospective longitudinal study shows that factors such as cognitive abilities,
1303 home environment qualities, and neighborhood cohesion protect children with
1304 exposure to multiple victimization experiences from later psychotic symptoms.**
1305 224 Allen, J., Balfour, R., Bell, R. & Marmot, M. Social determinants of mental health. *Int Rev
1306 Psychiatry* **26**, 392-407 (2014).
1307 225 Crush, E., Arseneault, L. & Fisher, H. L. Girls get by with a little help from their friends:
1308 gender differences in protective effects of social support for psychotic phenomena
1309 amongst poly-victimised adolescents. *Soc. Psychiatry Psychiatr. Epidemiol.* **53**, 1413-
1310 1417 (2018).
1311 226 Crush, E., Arseneault, L., Danese, A., Jaffee, S. R. & Fisher, H. L. Using discordant twin
1312 methods to investigate an environmentally mediated pathway between social support
1313 and the reduced likelihood of adolescent psychotic experiences. *Psychol. Med.* **50**,
1314 1898-1905 (2020).

1315 227 Riches, S. *et al.* Protective Factors for Early Psychotic Phenomena Among Children of
1316 Mothers With Psychosis. *Front Psychiatry* **9**, 750 (2018).
1317 228 Pruessner, M., Iyer, S. N., Faridi, K., Joober, R. & Malla, A. K. Stress and protective
1318 factors in individuals at ultra-high risk for psychosis, first episode psychosis and healthy
1319 controls. *Schizophr. Res.* **129**, 29-35 (2011).
1320 229 Norman, R. M. *et al.* Social support and three-year symptom and admission outcomes
1321 for first episode psychosis. *Schizophr. Res.* **80**, 227-234 (2005).
1322 230 Lim, M. H., Gleeson, J. F., Jackson, H. J. & Fernandez, K. C. Social relationships and
1323 quality of life moderate distress associated with delusional ideation. *Soc. Psychiatry*
1324 *Psychiatr. Epidemiol.* **49**, 97-107 (2014).
1325 **This paper highlights the importance of both receiving and giving social support**
1326 **in buffering against distress associated with persistent psychotic experiences.**
1327 231 Angell, B. & Test, M. A. The relationship of clinical factors and environmental
1328 opportunities to social functioning in young adults with schizophrenia. *Schizophr. Bull.*
1329 **28**, 259-271 (2002).
1330 232 Norman, R. M., Windell, D., Manchanda, R., Harricharan, R. & Northcott, S. Social
1331 support and functional outcomes in an early intervention program. *Schizophr. Res.* **140**,
1332 37-40 (2012).
1333 233 Robustelli, B. L., Newberry, R. E., Whisman, M. A. & Mittal, V. A. Social relationships in
1334 young adults at ultra high risk for psychosis. *Psychiatry Res.* **247**, 345-351 (2017).
1335 234 Gan, G. *et al.* Neural Correlates of Affective Benefit From Real-life Social Contact and
1336 Implications for Psychiatric Resilience. *JAMA Psychiatry* **78**, 790-792 (2021).
1337 235 Bjornestad, J. *et al.* "With a little help from my friends" social predictors of clinical
1338 recovery in first-episode psychosis. *Psychiatry Res.* **255**, 209-214 (2017).
1339 236 O'Keeffe, D. *et al.* The iHOPE-20 study: Relationships between and prospective
1340 predictors of remission, clinical recovery, personal recovery and resilience 20 years on
1341 from a first episode psychosis. *Aust. N. Z. J. Psychiatry* **53**, 1080-1092 (2019).
1342 237 Myin-Germeys, I., Nicolson, N. A. & Delespaul, P. A. The context of delusional
1343 experiences in the daily life of patients with schizophrenia. *Psychol. Med.* **31**, 489-498
1344 (2001).
1345 **This study uses experience sampling methodology and shows that the mere**
1346 **presence of family or acquantainces decreases the probability of the experience**
1347 **of delusional thoughts in individuals with schizophrenia.**
1348 238 Malmberg, A., Lewis, G., David, A. & Allebeck, P. Premorbid adjustment and personality
1349 in people with schizophrenia. *Br. J. Psychiatry* **172**, 308-313; discussion 314-305
1350 (1998).
1351 239 Deegan, P. E. The importance of personal medicine: a qualitative study of resilience in
1352 people with psychiatric disabilities. *Scand J Public Health Suppl* **66**, 29-35 (2005).
1353 240 March, D. *et al.* Psychosis and place. *Epidemiol. Rev.* **30**, 84-100 (2008).
1354 241 Veling, W. *et al.* Ethnic density of neighborhoods and incidence of psychotic disorders
1355 among immigrants. *Am. J. Psychiatry* **165**, 66-73 (2008).
1356 **This prospective study shows that the incidence of psychotic disorders was**
1357 **elevated among immigrants living in neighborhoods where their ethnic group was**
1358 **a small proportion of the neighborhood population.**
1359 242 Bosqui, T. J., Hoy, K. & Shannon, C. A systematic review and meta-analysis of the
1360 ethnic density effect in psychotic disorders. *Soc. Psychiatry Psychiatr. Epidemiol.* **49**,
1361 519-529 (2014).
1362 243 Li, D., Ramos, M. R., Bennett, M. R., Massey, D. S. & Hewstone, M. Does ethnic
1363 diversity affect well-being and allostatic load among people across neighbourhoods in
1364 England? *Health Place* **68**, 102518 (2021).

1365 244 van der Meer, T. & Tolsma, J. Ethnic Diversity and Its Effects on Social Cohesion. *Annual Review of Sociology* **40**, 459-478 (2014).
1367 245 Ramos, M. R., Bennett, M. R., Massey, D. S. & Hewstone, M. Humans adapt to social diversity over time. *Proc. Natl. Acad. Sci. U. S. A.* **116**, 12244-12249 (2019).
1369 246 Becares, L., Nazroo, J. & Stafford, M. The buffering effects of ethnic density on experienced racism and health. *Health Place* **15**, 670-678 (2009).
1371 247 Maxwell, J. in *Eric John Hanson Memorial Lecture Series* Vol. 8 (University of Alberta, 1996).
1373 248 Ansari, S. Social Capital and Collective Efficacy: Resource and Operating Tools of Community Social Control. *Journal of Theoretical & Philosophical Criminology* **5**, 75-94 (2013).
1376 249 Schneider, J., Arthur, A., Doody, G., Simpson, J. & Jones, P. Individual social capital and psychosis: secondary analysis of AESOP data for Nottingham. *Mental Health Rev* **14**, 4-12 (2009).
1379 250 Kirkbride, J. B. *et al.* Neighbourhood-level effects on psychoses: re-examining the role of context. *Psychol. Med.* **37**, 1413-1425 (2007).
1381 251 Lofors, J. & Sundquist, K. Low-linking social capital as a predictor of mental disorders: a cohort study of 4.5 million Swedes. *Soc. Sci. Med.* **64**, 21-34 (2007).
1383 252 Rotenberg, M., Anderson, K. K. & McKenzie, K. Social capital and psychosis: a scoping review. *Soc. Psychiatry Psychiatr. Epidemiol.* **55**, 659-671 (2020).
1385 253 Selten, J. P., van der Ven, E., Rutten, B. P. & Cantor-Graae, E. The social defeat hypothesis of schizophrenia: an update. *Schizophr. Bull.* **39**, 1180-1186 (2013).
1387 254 Gevonden, M. *et al.* Increased release of dopamine in the striata of young adults with hearing impairment and its relevance for the social defeat hypothesis of schizophrenia. *JAMA Psychiatry* **71**, 1364-1372 (2014).
1390 255 Bratman, G. N. *et al.* Nature and mental health: An ecosystem service perspective. *Sci Adv* **5**, eaax0903 (2019).
1392 256 Buxton, R. T., Pearson, A. L., Allou, C., Fristrup, K. & Wittemyer, G. A synthesis of health benefits of natural sounds and their distribution in national parks. *Proc. Natl. Acad. Sci. U. S. A.* **118** (2021).
1395 257 Engemann, K. *et al.* Childhood exposure to green space - A novel risk-decreasing mechanism for schizophrenia? *Schizophr. Res.* **199**, 142-148 (2018).
1397 258 Engemann, K. *et al.* Natural surroundings in childhood are associated with lower schizophrenia rates. *Schizophr. Res.* **216**, 488-495 (2020).
1399 **This large population-cohort study shows that childhood exposure to natural environments was associated with a reduced chance of being diagnosed with schizophrenia later in life.**
1402 259 Engemann, K. *et al.* Association Between Childhood Green Space, Genetic Liability, and the Incidence of Schizophrenia. *Schizophr. Bull.* **46**, 1629-1637 (2020).
1404 260 Fett, A. J., Lemmers-Jansen, I. L. J. & Krabbendam, L. Psychosis and urbanicity: a review of the recent literature from epidemiology to neurourbanism. *Curr Opin Psychiatry* **32**, 232-241 (2019).
1407 261 Henson, P., Pearson, J. F., Keshavan, M. & Torous, J. Impact of dynamic greenspace exposure on symptomatology in individuals with schizophrenia. *PLoS One* **15**, e0238498 (2020).
1410 262 Kaplan, S. The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology* **15**, 169-182 (1995).
1412 263 Kellert, S. R. & Wilson, E. O. *The Biophilia hypothesis.* (Island Press/Shearwater Books, 1993).
1414 264 Söderström, O. *et al.* Unpacking 'the City': An experience-based approach to the role of urban living in psychosis. *Health Place* **42**, 104-110 (2016).

1416 265 Shin, W. S., Yeoun, P. S., Yoo, R. W. & Shin, C. S. Forest experience and psychological
1417 health benefits: the state of the art and future prospect in Korea. *Environ Health Prev*
1418 *Med* **15**, 38-47 (2010).
1419 266 Rosa, C. D., Larson, L. R., Collado, S. & Profice, C. C. Forest therapy can prevent and
1420 treat depression: Evidence from meta-analyses. *Urban Forestry & Urban Greening* **57**
1421 (2021).
1422 267 Zabini, F. *et al.* Comparative Study of the Restorative Effects of Forest and Urban
1423 Videos during COVID-19 Lockdown: Intrinsic and Benchmark Values. *Int J Environ Res*
1424 *Public Health* **17** (2020).
1425 268 Brancato, G., Van Hedger, K., Berman, M. G. & Van Hedger, S. C. Simulated nature
1426 walks improve psychological well-being along a natural to urban continuum. *Journal of*
1427 *Environmental Psychology* **81** (2022).
1428 269 Bielinis, E., Jaroszewska, A., Łukowski, A. & Takayama, N. The Effects of a Forest
1429 Therapy Programme on Mental Hospital Patients with Affective and Psychotic Disorders.
1430 *Int J Environ Res Public Health* **17** (2019).
1431 270 Moore, T. H. M. *et al.* The effects of changes to the built environment on the mental
1432 health and well-being of adults: Systematic review. *Health Place* **53**, 237-257 (2018).
1433 271 Roe, J. *et al.* The Urban Built Environment, Walking and Mental Health Outcomes
1434 Among Older Adults: A Pilot Study. *Front Public Health* **8**, 575946 (2020).
1435 272 Renalds, A., Smith, T. H. & Hale, P. J. A systematic review of built environment and
1436 health. *Fam. Community Health* **33**, 68-78 (2010).
1437 273 Rautio, N., Filatova, S., Lehtiniemi, H. & Miettunen, J. Living environment and its
1438 relationship to depressive mood: A systematic review. *Int. J. Soc. Psychiatry* **64**, 92-103
1439 (2018).
1440 274 Song, J. *et al.* Built environment and schizophrenia re-hospitalization risk in China: A
1441 cohort study. *Environ. Res.* **227**, 115816 (2023).
1442 275 Vancampfort, D. *et al.* Associations between physical activity and the built environment
1443 in patients with schizophrenia: a multi-centre study. *Gen. Hosp. Psychiatry* **35**, 653-658
1444 (2013).
1445 276 Vancampfort, D. *et al.* Associations of the Built Environment With Physical Activity and
1446 Sedentary Time in Ugandan Outpatients With Mental Health Problems. *J Phys Act*
1447 *Health* **16**, 243-250 (2019).
1448 277 Vancampfort, D. *et al.* Associations between perceived neighbourhood environmental
1449 attributes and self-reported sitting time in patients with schizophrenia: a pilot study.
1450 *Psychiatry Res.* **215**, 33-38 (2014).
1451 278 Chaiyachati, K. H., Hom, J. K., Hubbard, R. A., Wong, C. & Grande, D. Evaluating the
1452 association between the built environment and primary care access for new Medicaid
1453 enrollees in an urban environment using Walk and Transit Scores. *Prev Med Rep* **9**, 24-
1454 28 (2018).
1455 279 Ungar, M. The differential impact of social services on young people's resilience. *Child*
1456 *Abuse Negl.* **78**, 4-12 (2018).
1457 280 Engemann, K. *et al.* Residential green space in childhood is associated with lower risk of
1458 psychiatric disorders from adolescence into adulthood. *Proc. Natl. Acad. Sci. U. S. A.*
1459 **116**, 5188-5193 (2019).
1460 281 Heller, A. S. *et al.* Association between real-world experiential diversity and positive
1461 affect relates to hippocampal-striatal functional connectivity. *Nat. Neurosci.* **23**, 800-804
1462 (2020).
1463 282 Werker, J. F. & Hensch, T. K. Critical periods in speech perception: new directions.
1464 *Annu. Rev. Psychol.* **66**, 173-196 (2015).
1465 283 Frankenhuis, W. E. & Walasek, N. Modeling the evolution of sensitive periods. *Dev Cogn*
1466 *Neurosci* **41**, 100715 (2020).

1467 284 Gee, D. G. When do sensitive periods emerge later in development? *Trends Cogn Sci* **26**, 97-98 (2022).
1469 285 Walasek, N., Frankenhuis, W. E. & Panchanathan, K. An evolutionary model of sensitive periods when the reliability of cues varies across ontogeny. *Behav Ecol* **33**, 101-114 (2022).
1472 286 Theron, L. C. & Liebenberg, L. in *Youth Resilience and Culture. Cross Cultural Advancements in Positive Psychology* Vol. 11 (eds L. Theron, L. Liebenberg, & M. Ungar) (Springer, 2015).
1475 287 Ungar, M. A Constructionist Discourse on Resilience: Multiple Contexts, Multiple Realities among At-Risk Children and Youth. *Youth and Society* **35**, 341-365 (2004).
1477 288 Lin, K. M. & Kleinman, A. M. Psychopathology and clinical course of schizophrenia: a cross-cultural perspective. *Schizophr. Bull.* **14**, 555-567 (1988).
1479 289 Luhrmann, T. M. Social defeat and the culture of chronicity: or, why schizophrenia does so well over there and so badly here. *Cult. Med. Psychiatry* **31**, 135-172 (2007).
1481 290 Craig, T. J., Siegel, C., Hopper, K., Lin, S. & Sartorius, N. Outcome in schizophrenia and related disorders compared between developing and developed countries. A recursive partitioning re-analysis of the WHO DOSMD data. *Br. J. Psychiatry* **170**, 229-233 (1997).
1485 291 Harrison, G. *et al.* Recovery from psychotic illness: a 15- and 25-year international follow-up study. *Br. J. Psychiatry* **178**, 506-517 (2001).
1487 292 Hopper, K. in *Schizophrenia, culture and subjectivity* (eds J. H. Jenkins & R. J. Barrett) 62-86 (Cambridge University Press, 2004).
1489 293 Hopper, K. Rethinking social recovery in schizophrenia: what a capabilities approach might offer. *Soc. Sci. Med.* **65**, 868-879 (2007).
1491 294 Thara, R. & Anuradha. Cognitive functioning in schizophrenia : its relevance to rehabilitation. *Indian J. Med. Res.* **126**, 414-416 (2007).
1493 295 Thara, R. & Eaton, W. W. Outcome of schizophrenia: the Madras longitudinal study. *Aust. N. Z. J. Psychiatry* **30**, 516-522 (1996).
1495 296 Kane, J. M. *et al.* Comprehensive Versus Usual Community Care for First-Episode Psychosis: 2-Year Outcomes From the NIMH RAISE Early Treatment Program. *Am. J. Psychiatry* **173**, 362-372 (2016).
1498 297 Bennett, D. & Rosenheck, R. Socioeconomic status and the effectiveness of treatment for first-episode psychosis. *Health Serv. Res.* **56**, 409-417 (2021).
1500 **This follow-up analysis from a large treatment study shows that the initially promising effects of a coordinated specialty care intervention for early psychosis that adopts a strengths and resilience based approach were limited to those at the top 25% of the socioeconomic distribution.**
1504 298 Fusar-Poli, P. *et al.* Preventive psychiatry: a blueprint for improving the mental health of young people. *World Psychiatry* **20**, 200-221 (2021).
1506 299 DeTore, N. R. *et al.* Efficacy of a transdiagnostic, prevention-focused program for at-risk young adults: a waitlist-controlled trial. *Psychol. Med.*, 1-10 (2022).
1508 300 Burke, A. S. *et al.* Rationale, Methods, Feasibility, and Preliminary Outcomes of a Transdiagnostic Prevention Program for At-Risk College Students. *Front Psychiatry* **10**, 1030 (2019).
1511 301 Shah, J. L., Jones, N., van Os, J., McGorry, P. D. & Guloksuz, S. Early intervention service systems for youth mental health: integrating pluripotentiality, clinical staging, and transdiagnostic lessons from early psychosis. *Lancet Psychiatry* **9**, 413-422 (2022).
1514 302 Hartmann, J. A. *et al.* Pluripotential Risk and Clinical Staging: Theoretical Considerations and Preliminary Data From a Transdiagnostic Risk Identification Approach. *Front Psychiatry* **11**, 553578 (2020).

1517 303 Bonanno, G. A. Loss, trauma, and human resilience: have we underestimated the
1518 human capacity to thrive after extremely aversive events? *Am. Psychol.* **59**, 20-28
1519 (2004).
1520 304 Erlenmeyer-Kimling, L. & Cornblatt, B. The New York High-Risk Project: a followup
1521 report. *Schizophr. Bull.* **13**, 451-461 (1987).
1522 305 Mednick, S. A., Parnas, J. & Schulsinger, F. The Copenhagen High-Risk Project, 1962-
1523 86. *Schizophr. Bull.* **13**, 485-495 (1987).
1524 306 Addington, J. *et al.* North American Prodrome Longitudinal Study: a collaborative
1525 multisite approach to prodromal schizophrenia research. *Schizophr. Bull.* **33**, 665-672
1526 (2007).
1527 307 Addington, J. *et al.* North American Prodrome Longitudinal Study (NAPLS 2): overview
1528 and recruitment. *Schizophr. Res.* **142**, 77-82 (2012).
1529 308 Liu, R. T. A developmentally informed perspective on the relation between stress and
1530 psychopathology: when the problem with stress is that there is not enough. *J. Abnorm.*
1531 *Psychol.* **124**, 80-92 (2015).
1532 309 Minor, K. S. *et al.* Personalizing interventions using real-world interactions: Improving
1533 symptoms and social functioning in schizophrenia with tailored metacognitive therapy. *J.*
1534 *Consult. Clin. Psychol.* **90**, 18-28 (2022).
1535 310 Raugh, I. M. *et al.* Geolocation as a Digital Phenotyping Measure of Negative Symptoms
1536 and Functional Outcome. *Schizophr. Bull.* **46**, 1596-1607 (2020).
1537 311 Fulford, D. *et al.* Smartphone sensing of social interactions in people with and without
1538 schizophrenia. *J. Psychiatr. Res.* **137**, 613-620 (2021).
1539 312 Rapado-Castro, M., McGorry, P. D., Yung, A., Calvo, A. & Nelson, B. Sources of clinical
1540 distress in young people at ultra high risk of psychosis. *Schizophr. Res.* **165**, 15-21
1541 (2015).
1542 313 Masten, A. S. Ordinary magic. Resilience processes in development. *Am. Psychol.* **56**,
1543 227-238 (2001).
1544 314 Global Burden of Disease Collaborative Network. *Global Burden of Disease Study 2017*
1545 *Results*. (2017).
1546 315 Kraepelin, E. *Dementia Praecox and Paraphrenia*. (Chicago Medical Book Co., 1919).
1547 316 Rapoport, J. L., Giedd, J. N. & Gogtay, N. Neurodevelopmental model of schizophrenia:
1548 update 2012. *Mol. Psychiatry* **17**, 1228-1238 (2012).
1549 317 Jacobs, G. D., Pace-Schott, E. F., Stickgold, R. & Otto, M. W. Cognitive behavior
1550 therapy and pharmacotherapy for insomnia: a randomized controlled trial and direct
1551 comparison. *Arch. Intern. Med.* **164**, 1888-1896 (2004).
1552 318 Ritterband, L. M. *et al.* Efficacy of an Internet-based behavioral intervention for adults
1553 with insomnia. *Arch. Gen. Psychiatry* **66**, 692-698 (2009).
1554 319 Irish, L. A., Kline, C. E., Gunn, H. E., Buysse, D. J. & Hall, M. H. The role of sleep
1555 hygiene in promoting public health: A review of empirical evidence. *Sleep Med Rev* **22**,
1556 23-36 (2015).
1557 320 Hale, L., Troxel, W. & Buysse, D. J. Sleep Health: An Opportunity for Public Health to
1558 Address Health Equity. *Annu. Rev. Public Health* **41**, 81-99 (2020).
1559 321 Morgan, A. J., Parker, A. G., Alvarez-Jimenez, M. & Jorm, A. F. Exercise and mental
1560 health: an Exercise and Sports Science Australia commissioned review. *Journal of*
1561 *Exercise Physiology Online* **16**, 64-73 (2013).
1562 322 Firth, J., Cotter, J., Elliott, R., French, P. & Yung, A. R. A systematic review and meta-
1563 analysis of exercise interventions in schizophrenia patients. *Psychol. Med.* **45**, 1343-
1564 1361 (2015).
1565 323 Damme, K. S. F. *et al.* Exercise Intervention in Individuals at Clinical High Risk for
1566 Psychosis: Benefits to Fitness, Symptoms, Hippocampal Volumes, and Functional
1567 Connectivity. *Schizophr. Bull.* (2022).

1568 324 Pizzoli, S. F. M. *et al.* A meta-analysis on heart rate variability biofeedback and
1569 depressive symptoms. *Sci Rep* **11**, 6650 (2021).
1570 325 Schlier, B., Ludwig, L., Wiesjahn, M., Jung, E. & Lincoln, T. M. Fostering coping as a
1571 mechanism of symptom change in cognitive behavioural therapy for psychosis.
1572 *Schizophr. Res.* **215**, 416-423 (2020).
1573 326 Wykes, T., Steel, C., Everitt, B. & Tarrier, N. Cognitive behavior therapy for
1574 schizophrenia: effect sizes, clinical models, and methodological rigor. *Schizophr. Bull.*
1575 **34**, 523-537 (2008).
1576 327 Fusar-Poli, P. *et al.* Preventive Treatments for Psychosis: Umbrella Review (Just the
1577 Evidence). *Front Psychiatry* **10**, 764 (2019).
1578 328 Meyer, P. S., Gottlieb, J. D., Penn, D., Mueser, K. & Gingerich, S. Individual resiliency
1579 training: An early intervention approach to enhance well-being in people with first-
1580 episode psychosis. *Psychiatric Annals* **45**, 554–560 (2015).
1581 329 Niveau, N., New, B. & Beaudoin, M. Self-esteem Interventions in Adults – A Systematic
1582 Review and Meta-analysis. *J Res Pers* **94**, 104131 (2021).
1583 330 Arzy, S., Thut, G., Mohr, C., Michel, C. M. & Blanke, O. Neural basis of embodiment:
1584 distinct contributions of temporoparietal junction and extrastriate body area. *J. Neurosci.*
1585 **26**, 8074-8081 (2006).
1586 331 Tsang, H. W. *et al.* Therapeutic intervention for internalized stigma of severe mental
1587 illness: A systematic review and meta-analysis. *Schizophr. Res.* **173**, 45-53 (2016).
1588 332 Pargament, K. I. & Lomax, J. W. Understanding and addressing religion among people
1589 with mental illness. *World Psychiatry* **12**, 26-32 (2013).
1590 333 Weisman de Mamani, A., Tuchman, N. & Duarte, E. A. Incorporating Religion/Spirituality
1591 Into Treatment for Serious Mental Illness. *Cognitive and Behavioral Practice* **17**, 348-357
1592 (2010).
1593 334 Granholm, E. L., McQuaid, J. R. & Holden, J. L. *Cognitive-behavioral social skills training*
1594 *for schizophrenia: A practical treatment guide.*, (Guilford Publications, 2016).
1595 335 Horan, W. P. *et al.* Social cognitive skills training in schizophrenia: an initial efficacy
1596 study of stabilized outpatients. *Schizophr. Res.* **107**, 47-54 (2009).
1597 336 Roberts, D. L. *et al.* A randomized, controlled trial of Social Cognition and Interaction
1598 Training (SCIT) for outpatients with schizophrenia spectrum disorders. *Br. J. Clin.*
1599 *Psychol.* **53**, 281-298 (2014).
1600 337 Nahum, M. *et al.* Online Social Cognition Training in Schizophrenia: A Double-Blind,
1601 Randomized, Controlled Multi-Site Clinical Trial. *Schizophr. Bull.* **47**, 108-117 (2021).
1602 338 Vita, A. *et al.* Effectiveness, Core Elements, and Moderators of Response of Cognitive
1603 Remediation for Schizophrenia: A Systematic Review and Meta-analysis of Randomized
1604 Clinical Trials. *JAMA Psychiatry* **78**, 848-858 (2021).
1605 339 Wykes, T., Huddy, V., Cellard, C., McGurk, S. R. & Czobor, P. A meta-analysis of
1606 cognitive remediation for schizophrenia: methodology and effect sizes. *Am. J. Psychiatry*
1607 **168**, 472-485 (2011).
1608 340 Glenthoj, L. B., Hjorthoj, C., Kristensen, T. D., Davidson, C. A. & Nordentoft, M. The
1609 effect of cognitive remediation in individuals at ultra-high risk for psychosis: a systematic
1610 review. *NPJ Schizophr* **3**, 20 (2017).
1611 341 Hogan, B. E., Linden, W. & Najarian, B. Social support interventions: do they work? *Clin.*
1612 *Psychol. Rev.* **22**, 383-442 (2002).
1613 342 White, S. *et al.* The effectiveness of one-to-one peer support in mental health services: a
1614 systematic review and meta-analysis. *BMC Psychiatry* **20**, 534 (2020).
1615 343 Liu, C. H., Keshavan, M. S., Tronick, E. & Seidman, L. J. Perinatal Risks and Childhood
1616 Premorbid Indicators of Later Psychosis: Next Steps for Early Psychosocial
1617 Interventions. *Schizophr. Bull.* **41**, 801-816 (2015).

1618 344 Bauer, A. *et al.* Mobilising social support to improve mental health for children and
1619 adolescents: A systematic review using principles of realist synthesis. *PLoS One* **16**,
1620 e0251750 (2021).
1621 345 Webber, M. & Fendt-Newlin, M. A review of social participation interventions for people
1622 with mental health problems. *Soc. Psychiatry Psychiatr. Epidemiol.* **52**, 369-380 (2017).
1623 346 Semenza, J. C. & March, T. L. An urban community-based intervention to advance
1624 social interactions. *Environment and Behavior* **41**, 22-42 (2009).
1625 347 Cohen, D. A., Inagami, S. & Finch, B. The built environment and collective efficacy.
1626 *Health Place* **14**, 198-208 (2008).
1627 348 Hunter, R. F. *et al.* Environmental, health, wellbeing, social and equity effects of urban
1628 green space interventions: A meta-narrative evidence synthesis. *Environ Int* **130**,
1629 104923 (2019).
1630 349 South, E. C., Hohl, B. C., Kondo, M. C., MacDonald, J. M. & Branas, C. C. Effect of
1631 Greening Vacant Land on Mental Health of Community-Dwelling Adults: A Cluster
1632 Randomized Trial. *JAMA Netw Open* **1**, e180298 (2018).
1633 350 Organization, W. H. Urban Green Space and Health: Intervention Impacts and
1634 Effectiveness. (Copenhagen, Denmark, 2017).
1635 351 Dauwan, M., Begemann, M. J., Heringa, S. M. & Sommer, I. E. Exercise Improves
1636 Clinical Symptoms, Quality of Life, Global Functioning, and Depression in
1637 Schizophrenia: A Systematic Review and Meta-analysis. *Schizophr. Bull.* **42**, 588-599
1638 (2016).
1639 352 Tao, F. B. *et al.* Physical activity might not be the protective factor for health risk
1640 behaviours and psychopathological symptoms in adolescents. *J. Paediatr. Child Health*
1641 **43**, 762-767 (2007).
1642 353 Chekroud, S. R. *et al.* Association between physical exercise and mental health in 1·2
1643 million individuals in the USA between 2011 and 2015: a cross-sectional study. *Lancet*
1644 *Psychiatry* **5**, 739-746 (2018).
1645 354 Firth, J., Schuch, F. & Mittal, V. A. Using exercise to protect physical and mental health
1646 in youth at risk for psychosis. *Res Psychother* **23**, 433 (2020).
1647 355 Dawkins, M. P., Williams, M. M. & Guilbault, M. Participation in school sports: risk or
1648 protective factor for drug use among black and white students. *Journal of Negro*
1649 *Education* **75**, 25-33 (2006).
1650 356 Quinton, D., Rutter, M. & Liddle, C. Institutional rearing, parenting difficulties and marital
1651 support. *Psychol. Med.* **14**, 107-124 (1984).
1652 357 Crawford, J. R. & Henry, J. D. The positive and negative affect schedule (PANAS):
1653 construct validity, measurement properties and normative data in a large non-clinical
1654 sample. *Br. J. Clin. Psychol.* **43**, 245-265 (2004).
1655 358 Bell, V., Halligan, P. W. & Ellis, H. D. Explaining delusions: a cognitive perspective.
1656 *Trends Cogn Sci* **10**, 219-226 (2006).
1657 359 Freeman, D. *et al.* Comparison of a theoretically driven cognitive therapy (the Feeling
1658 Safe Programme) with befriending for the treatment of persistent persecutory delusions:
1659 a parallel, single-blind, randomised controlled trial. *Lancet Psychiatry* **8**, 696-707 (2021).
1660 360 Mehl, S., Werner, D. & Lincoln, T. M. Does Cognitive Behavior Therapy for psychosis
1661 (CBTp) show a sustainable effect on delusions? A meta-analysis. *Front Psychol* **6**, 1450
1662 (2015).
1663 361 Fried, E. I., Koenders, M. A. & Blom, J. D. Bleuler revisited: on persecutory delusions
1664 and their resistance to therapy. *Lancet Psychiatry* **8**, 644-646 (2021).
1665 362 Ritunnano, R., Broome, M. & Stanghellini, G. Charting New Phenomenological Paths for
1666 Empirical Research on Delusions: Embracing Complexity, Finding Meaning. *JAMA*
1667 *Psychiatry* **78**, 1063-1064 (2021).

1668 363 Feyaerts, J., Henriksen, M. G., Vanheule, S., Myin-Germeys, I. & Sass, L. A. Delusions
1669 beyond beliefs: a critical overview of diagnostic, aetiological, and therapeutic
1670 schizophrenia research from a clinical-phenomenological perspective. *Lancet Psychiatry*
1671 **8**, 237-249 (2021).
1672 364 Ritunnano, R., Humpston, C. & Broome, M. R. Finding order within the disorder: a case
1673 study exploring the meaningfulness of delusions. *BJPsych Bull*, 1-7 (2021).
1674 365 Bilu, Y., Witztum, E. & van der Hart, O. Paradise regained: "miraculous healing" in an
1675 Israeli psychiatric clinic. *Cult. Med. Psychiatry* **14**, 105-127 (1990).
1676 366 Appelbaum, P. S., Robbins, P. C. & Roth, L. H. Dimensional approach to delusions:
1677 comparison across types and diagnoses. *Am. J. Psychiatry* **156**, 1938-1943 (1999).
1678 367 Coid, J. W. *et al.* The relationship between delusions and violence: findings from the
1679 East London first episode psychosis study. *JAMA Psychiatry* **70**, 465-471 (2013).
1680 368 Roberts, G. Delusional belief systems and meaning in life: a preferred reality? *Br. J.*
1681 *Psychiatry. Suppl.*, 19-28 (1991).
1682 369 Rutunnano, R. & Bortolotti, L. Do delusions have and give meaning? *Phenomenology*
1683 *and the Cognitive Sciences*, 1-20 (2021).
1684 370 Chennaoui, M., Arnal, P. J., Sauvet, F. & Léger, D. Sleep and exercise: A reciprocal
1685 issue? *Sleep Medicine Reviews* **20**, 59-72 (2015).
1686 371 Minkel, J. *et al.* Sleep deprivation potentiates HPA axis stress reactivity in healthy adults.
1687 *Health Psychol.* **33**, 1430-1434 (2014).
1688 372 Hamilton, J. L. & Alloy, L. B. Atypical reactivity of heart rate variability to stress and
1689 depression across development: Systematic review of the literature and directions for
1690 future research. *Clin. Psychol. Rev.* **50**, 67-79 (2016).
1691 373 Joao, K., Jesus, S. N., Carmo, C. & Pinto, P. The impact of sleep quality on the mental
1692 health of a non-clinical population. *Sleep Med* **46**, 69-73 (2018).
1693 374 Sallis, J. F. *et al.* Built Environment, Physical Activity, and Obesity: Findings from the
1694 International Physical Activity and Environment Network (IPEN) Adult Study. *Annu. Rev.*
1695 *Public Health* **41**, 119-139 (2020).
1696 375 Marshall, S. L., Parker, P. D., Ciarrochi, J. & Heaven, P. C. L. Is self-esteem a cause or
1697 consequence of social support? A 4-year longitudinal study. *Child Dev.* **85**, 1275-1291
1698 (2014).
1699 376 Ludyga, S., Gerber, M., Puhse, U., Looser, V. N. & Kamijo, K. Systematic review and
1700 meta-analysis investigating moderators of long-term effects of exercise on cognition in
1701 healthy individuals. *Nat Hum Behav* **4**, 603-612 (2020).
1702 377 Soundy, A. *et al.* The transcending benefits of physical activity for individuals with
1703 schizophrenia: a systematic review and meta-ethnography. *Psychiatry Res.* **220**, 11-19
1704 (2014).
1705 378 Astell-Burt, T., Feng, X., Mavoa, S., Badland, H. M. & Giles-Corti, B. Do low-income
1706 neighbourhoods have the least green space? A cross-sectional study of Australia's most
1707 populous cities. *BMC Public Health* **14**, 292 (2014).
1708
1709

Acknowledgements

The authors would like to thank Jackie Bao and Jessica Fattal for their help with the literature search.

Author contributions

K.N.T., A.M., K.S.M., C.S.H., & S.P wrote the article. All authors researched data for the article, contributed substantially to discussion of the content, and reviewed and/or edited the manuscript before submission.

Competing interests

The authors declare no competing interests.

Peer review information

Nature Reviews Psychology thanks Thomas Kwapil and Angus Macbeth for their contribution to the peer review of this work.

Publisher's note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

1728

1729 **Table 1. Summary of reviewed protective and promotive factors.**

Level	Factor	Key findings	Considerations for prevention and intervention
Biological	Sleep	Better sleep quality is associated with greater well-being[110,111] Sleep quality interventions decrease psychotic-like symptoms[112] Sleep quantity shows a non-linear relationship with well-being[114,115]	Cognitive behavioral therapy (CBT) for insomnia[317] is the first-line treatment for sleep disturbance and can be effectively delivered using scalable web-based programs[318] Sleep hygiene recommendations as stand-alone interventions without personalization are unlikely to be effective [319] Expand beyond the level of the individual and consider how social and environmental determinants might be modified to improve sleep health[320]
	Physical activity	Low to moderate exercise is associated with mental health benefits[116-118] Physical activity in childhood is associated with a lower likelihood of developing psychosis later in life[124-126] Physical activity is associated with positive clinical and functional outcomes and subjective well-being in individuals with psychotic disorders[127-131]	90 minutes of moderate to vigorous exercise per week can improve mental and physical health[321] among individuals diagnosed with psychotic disorders[322] and individuals at clinical high risk[323] Supervised exercise in group settings (versus solitary exercise) maximizes adherence to the exercise intervention in individuals diagnosed with psychotic disorders[322] Strategies for addressing barriers to exercise include establishing an incentive structure, using augmented reality, varying the exercise routine, and social support[130]

	Homeostatic regulation of the autonomic nervous system	Higher heart rate variability and respiratory sinus arrhythmia (within the normal range) are associated with better mental and physical health[135-138] Heart rate variability and respiratory sinus arrhythmia are lower in people with psychotic disorder and individual differences relate to clinical symptoms and daily functioning[142-146] Biofeedback training to enhance heart rate variability is associated with improved clinical symptoms[153,154]	Heart rate variability and respiratory sinus arrhythmia are modifiable through biofeedback training, breathing retraining, mindfulness practice, and physical exercise in the general population[147-152,324]
Psychological	Traits and personal characteristics	Adaptive coping is associated with less severe psychotic and psychotic-like symptoms in the general population[157,158,165] and clinical populations[160-164] Higher self-esteem is associated with reduced psychotic and psychotic-like symptom severity[168,169,173], improved quality of life[170] and general mental health in clinical populations[170,171], and reduced distress associated with psychotic experiences[172] Regaining internal locus of control is a major component of recovery in individuals with schizophrenia[175] and is associated with a lower likelihood of developing psychotic symptoms[176] Trait emotional stability, extraversion, and agreeableness are associated with better quality of life in individuals with schizophrenia[180-182]	Fostering coping might be a mechanism of symptom improvement in CBT for psychosis[325], although CBT does not lead to improvements in quality of life, subjective distress or functioning[326]. There is no evidence to favor any specific preventative treatment of psychosis (including CBT)[327]. Individualized Resiliency Training is a psychosocial intervention to enhance well-being among people with psychosis that focuses on education and skills training to foster adaptive coping strategies[328]. Face-to-face or scalable web-based CBT and reminiscence-based interventions that focus on reflecting upon autobiographical memories are associated with improved self-esteem[329].

	Attitudes and orientations	Stigma resistance is related to well-being and quality of life in individuals with psychotic disorders[187-189] Spirituality might confer mental health benefits in the general population[193,194]. Religion and religious practices might act as both a vulnerability factor[193,197,202] as well as a protective or promotive factor[196,203-205]. Among individuals diagnosed with a psychotic disorder, spirituality relates to adaptation in the face of adversity[196], is associated with better social functioning in young people at risk for psychosis[197], and might buffer against the distress associated with psychotic experiences[172,198] Ascribing meaning to anomalous experiences might buffer against the distress of psychotic experiences[210,211] and promote well-being in individuals diagnosed with schizophrenia[212]	Stigma reduction strategies that either attempt to alter stigmatizing beliefs and attitudes or enhance stigma-coping skills through improvements in self-esteem, empowerment, and help-seeking behavior are effective in reducing self-stigma[330], particularly when they include a psychoeducation component[331] Religion and spirituality might offer resources for support and meaning and/or exacerbate psychological distress. Thus, they should only be incorporated into psychotherapy after careful consideration. Incorporating religion and spirituality into treatment might be particularly important for individuals from underserved and minoritized backgrounds who have higher rates of religious beliefs and greater use of religious coping than the general population [206-209] and for whom religious and spiritual resources might be more accessible than other resilience-promoting factors[332,333].
	Abilities	Higher social competence is associated with reduced risk of relapse in patients with psychosis[216] and with reduced risk for and severity of psychotic-like experiences in at-risk individuals[217,218] Better neurocognitive abilities are associated with decreased risk for psychotic symptoms in at-risk youth[219-221,223], a better clinical course in individuals recently diagnosed with a psychotic disorder[222], and might buffer	Cognitive Behavioral Social Skills Training[334], Social Cognition Training[335], and Social Cognition and Interaction Training[336] involve live instruction, role plays, behavioral assignments, and/or computerized programs[337] to foster skills in emotion and social perception, theory of mind, and social problem solving in individuals with psychotic-spectrum illness. Cognitive remediation improves cognition and daily functioning in individuals with schizophrenia[338,339]

		against distress associated with psychotic symptoms[172].	and in individuals at high risk for psychosis[340], particularly when they include an active and trained therapist, repeated practice, structured development of cognitive strategies, and techniques to maximize transfer of cognitive improvement to real-world settings. Delivery in group and individual settings is equally effective.
Social	Social support and relationship quality	Greater social support is related to reduced psychotic experiences in young adults with significant psychosis risk [124,223,225-227] , and to reduced symptom severity[203,228,229] and improved functioning[229] in people diagnosed with a psychotic disorder. Mutually beneficial exchange of support (relationship reciprocity) is higher in individuals with persistent psychotic experiences that do not have a need for care versus those that do[230]. In individuals with schizophrenia, better relationship quality is related to reduced symptom severity[231] and predicts better functional outcomes three years later[232]. In individuals at clinical high risk for psychosis, better quality of relationships and number of relationships are related to reduced severity of psychotic experiences and better functioning[233]	Group and individual interventions in adolescents and adults aimed at enhancing the availability of social support through social skill development or increasing the degree of perceived support through cognitive restructuring show preliminary effectiveness. But results are mixed and methodological limitations preclude a definitive interpretation of these results[341] Family interventions aimed at improving family support are protective against relapse[216]. One-to-one peer support improves support provided by personal relationships when adjunctive to usual care for psychosis [342] Targeting families of children at higher risk for psychosis by increasing parental social support and parent training can enhance the quality of familial support provided to the child[343,344]
	Social network size and social interaction	Social interaction promotes positive mental health outcomes in the general population[234]. Interactions with close relations is associated with	Social participation interventions aim to build social networks and improve community integration for individuals with mental illness through activities that facilitate social interactions. The limited evidence available suggests

		improved psychotic symptoms[235-237] Number of relationships is associated with a reduced risk of developing schizophrenia 15 years post-baseline[238] and with reduced symptom severity in individuals diagnosed with schizophrenia[231].	potential benefit of social participation interventions for social networks. However, further work is needed[345].
	Social roles	Engagement in activities related to valued social roles reduces clinical symptoms and prevents relapse[237,239].	
	Broader social environment	High ethnic density[240-242], neighborhood social cohesion[124,223,227], and neighborhood social capital[249-251] are associated with reduced risk of developing a psychotic disorder.	Data reporting individual outcomes are limited, but modifications to physical neighborhood features (for example, increasing walkability) can increase opportunities for social interactions and improve civic engagement and collective efficacy[346,347]
Built and natural environment	Built environment characteristics	Characteristics of the built environment (for example, walkability and housing quality) contribute to positive mental health outcomes in the general population[271-273]. No studies have directly examined the impact of aspects of the built environment on positive outcomes in the context of psychosis risk.	Environmental modifications aimed at increasing public access to green space (for example, planting street trees and greening vacant lots) might broadly improve health outcomes[348-350]. Neighborhood walkability increases physical activity in individuals with schizophrenia[242-244]
	Exposure to natural space	Exposure to natural green and blue space during childhood is associated with reduced psychosis risk in adulthood[257-259] Exposure to green space is related to decreased severity of clinical symptoms in individuals diagnosed with schizophrenia[261] and might buffer against stress of urban environment[264]	Group and individual interventions to increase time spent in green space promote mental and physical health [265,266], including among individuals hospitalized for psychosis[269] and even in simulated or virtual formats[267,268].

Figure legends

Figure 1. Trajectories of psychosis risk and resilience. Example trajectories for psychological distress (top), psychotic and psychotic-like experiences (middle), and subjective well-being and psychosocial functioning (bottom) in individuals at risk for psychosis. Risk factors include the circumstances that increase the likelihood of being diagnosed with a psychotic disorder, the distress associated with the experience of psychotic symptoms themselves, and secondary events associated with a diagnosis of psychotic disorder (for example, poor physical health or discrimination). Blue represents an individual presenting with risk factors but not protective or promotive factors. The grey, yellow, and green trajectories represent different resilience-promoting processes. Adaptation (grey) occurs when the individual changes in ways that permit positive outcomes despite the impact of risk. Recovery (yellow) occurs when the individual initially experiences negative outcomes in response to risk, but later returns to a previous level of functioning. Finally, resistance and persistence (green) occur when the individual maintains their current trajectory despite risk. These trajectories are highly schematized and simplified examples and do not encompass all possible trajectories of an individual with psychosis risk factors. Rather, they are intended to provide an illustration of how resilience-promoting processes might be enacted in the context of psychosis risk factors.

Figure 2. Protective and promotive factors across the biopsychosocial-ecological system. Potential protective and promotive factors in the context of psychosis risk identified in the Review are organized within levels of a biopsychosocial-ecological system. The factors placed at the border of adjacent levels indicate that different aspects of these factors are best conceptualized as operating at multiple levels of the biopsychosocial-ecological system.

Box 1. Beyond semantics in the shift from risk to resilience

A shift away from risk and towards resilience could be perceived as merely semantic—that a focus on strengths and protection is more hopeful-sounding but conceptually identical to a risk-focused approach to prevention and intervention. But resilience scholars have presented several arguments supporting the idea that a shift from risk to resilience is more than an inversion of language[87]. First, a high 'dose' of a particular variable that buffers against the effect of risk exposure might do so via different processes or mechanisms than those by which a low 'dose' of that same variable exacerbates the effect of risk[22,87]. For example, physical activity (generally considered a promotive factor) has a non-linear relationship with mental health, such that more physical exercise is related to improved mental health up to a threshold, after which it increases the likelihood of poor mental health[351-354]. Those aspects of exercise at low to moderate 'doses' that confer benefits are likely not the same aspects that confer vulnerability at high doses.

Second, context matters: a particular factor or process that has protective or promotive effects in one context, group, or individual might operate as a vulnerability factor in another[87]. For example, participating in high school sports is protective against alcohol use in Black girls, but is associated with increased alcohol use in Black boys and white girls and boys[355]. Third, the 'active ingredient' by which a particular factor confers benefits might lie in the positive end of that factor. For example, in women raised in institutional care, being in a supportive marital relationship was related to improved parental quality as compared to women who were not in a supportive marital relationship; however, parenting quality was equivalent in women raising a child without a partner and women raising children in the context of a poor marital relationship. In other words, a supportive marital relationship was a protective or promotive factor, but there was no analogous vulnerability caused by a poor marital relationship[356]. Thus, focusing on the protective end of a variable— supportive marital relationship, in this example—might elucidate the mechanism or process by which variation in exposure to a given factor might buffer the negative effects of risk. Finally, outcome variables do not lie on a unidimensional spectrum. Presence of resilience factors is not equivalent to an absence of risk factors. In a similar way, positive and negative emotions represent different constructs[357] and 'feeling good' is not the same as 'not feeling bad'. Thus, a paradigmatic shift from risk to resilience represents a change in approach and framework, not just a matter of emphasis on language and terms.

Box 2. The case of delusions

Delusions (false and fixed beliefs that are not amenable to change despite conflicting evidence[359]) are a defining symptom of schizophrenia and are understood as harmful and dysfunctional. Delusions are also considered an important treatment target that is central to recovery from psychosis. Current explanatory models of delusions adopt neurocognitive approaches to belief formation, whereby delusions are thought to arise from normative reasoning in the context of anomalous experiences or reflect abnormalities in a normative belief formation process (for a review see [358]). These approaches have led to the development of cognitive-behavioral therapy (CBT) for delusions [359], which treat delusions as beliefs that can be challenged through standard techniques of reality testing and evaluation. However, the efficacy of CBT for delusions appears to be modest and its therapeutic ingredients remain unclear [360,361].

Delusions are notoriously difficult to dispel. However, the current definition and operationalization of delusions are fraught with epistemic hurdles that make it difficult to determine the borders of pathology [362,363]. Framing delusions as harmful beliefs that must be eliminated to achieve recovery from psychosis fails to consider the lived experience of the phenomenon and the broader sociocultural and psychological context. Specifically, some delusions might serve an adaptive purpose, at least temporarily [364,365]. This proposition is not intended to romanticize delusions or to downplay their seriousness. Indeed, delusions—particularly persecutory delusions—are associated with tremendous personal distress [366], and anger secondary to delusions has been found to increase an individual's risk for violent behavior [367].

To best grapple with these clinical realities, clinicians and researchers must consider that delusions might be an adaptive response in some cases, and notions of recovery and treatment must be reframed accordingly. Indeed, a meta-analysis indicated the improvements in positive symptoms (like delusions) with CBT were related to increases in hopelessness[326]. Quotes from a qualitative study wherein individuals with schizophrenia with a longstanding delusional belief were asked what their life would be like without their delusional belief further illustrate this point[368]:

> "It would all have been for nothing…it would be sadness…it would be wrong, I wouldn't accept it…that's futility - I would really miss it. A waste of a life, all my lives, all the way through."

> "I can't see that ever happening - psychic activity is part of my structure - my heart. If I lost it, I would be inert. I'd have to start all over again."

An alternative phenomenological account of delusions incorporates the phenomenology of the variety of reality experiences to fathom how individuals with delusions might evaluate and discover meaning in these experiential alterations[362]. Moving away from a purely mechanistic model of delusions that fails to acknowledge or incorporate the subjective, phenomenological illness narratives will be essential to defining recovery and positive outcomes in a manner that leaves intact the person's sense of self and ability to find meaning in experience[365,369]. From the perspective of the person with lived experience, delusions are not necessarily an irrational or false representation of reality; rather, such beliefs might bring a sense of meaningfulness to their life [369]—which might confer resilience.

Box 3. Integrating risk and resilience factors

Our categorization of potential protective and promotive factors reflects the current literature that tends to study factors in isolation or within a small selection of other risk or resilience factors. However, this approach obscures the fact that it is the interactions between various assets and abilities together with risk factors that engender the conditions under which resilience can occur[83]. First, interactions between various risk and resilience promoting factors can occur within levels. For example, the biological resilience promoting factors reviewed here (sleep quality, physical activity, and homeostatic regulation of the autonomic nervous system) influence each other through reciprocal interactions via physiological and psychological pathways[370] and might exert their impact on positive mental health outcomes via a common process, such as reducing stress reactivity[371-373]. Second, extensive interactions occur between levels. For example, physical activity is influenced by the walkability of the built environment[374], self-esteem increases perceived social support[375], and exercise promotes cognitive abilities[376]. Furthermore, these resilience promoting factors might also reduce exposure to stressors. For example, for individuals from minoritized ethnic groups, the protective effect of living in neighborhoods wherein their ethnic identity is well-represented might reduce the degree of discrimination they experience in day-to-day life[246]. Finally, the access or ability conferred by resilience promoting resources might be compromised by the illness itself. For example, qualitative studies indicate that symptoms and the sedative effects of medication pose barriers to engaging in physical activity[377]. Similarly, stigma and structural discrimination together with psychosocial disability might limit employment opportunities and thereby reduce opportunities to access resilience promoting resources associated with wealth (such as access to green space, which is less available in low-income neighborhoods[378]), and to engage in social networks.

Table of Contents blurb

Psychosis research has traditionally focused on vulnerability and the detrimental outcomes of risk exposure. In this Review, Thakkar et al. consider an alternative resilience-based approach focused on resources and strengths that might help protect against negative illness course among people at risk.