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Infectious disease concerns predict narrow friendship networks☆

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ABSTRACT

Friendship significantly influences our happiness and health, and in ancestral contexts, the support offered by friends would likely have delivered fitness benefits. Yet, increasing the size of one's friendship network may not always be advantageous. The increase in interpersonal interactions characteristic of larger friendship networks brings costs such as higher risk of exposure to germs and infectious diseases. In four studies (N = 2266), we examined how individual differences associated with responsivity to pathogenic costs, such as germ aversion, relate to the size and quality of real and desired friendship networks. We found that individuals with chronically high aversion to germs have smaller friendship networks compared to those low in germ aversion, particularly for casual friends and acquaintances. Germ-averse individuals both prefer and feel obligated to keep smaller networks, and as such, hold stronger and more rigid standards for their friends. Perceptions of the tradeoffs underlying these patterns are not fixed, however. Among highly germ-averse individuals, those prompted to believe these goals were complementary (e.g., friends providing support when ill) reported higher satisfaction with their friendship networks compared to those prompted to believe these goals were in conflict (e.g., catching illnesses from social gatherings). Emphasizing the complementary nature of these goals can mitigate the perceived disease-relevant costs of friendships, thereby enhancing satisfaction with social connections, even among those chronically concerned about germs. Individual differences in infectious disease concerns thus play a meaningful role in explaining social network patterns.

1. Introduction

Creating and maintaining friendships is a central aspect of social life (Baumeister & Leary, 1995; DeScioli & Kurzban, 2009; Dunbar, 2018; Fehr, 1996). People invest significant time and effort into social interaction and development of emotional bonds, resulting in relationships that are essential for physical and mental well-being (Demir, Şimşek, & Procsal, 2013; Diener & Seligman, 2002; Smith & Christakis, 2008; Tay & Diener, 2011). From an evolutionary perspective, friendship is a unique type of relationship that forms spontaneously between non-kin, allowing individuals to meet long-term affiliation needs outside of kinship or strict reciprocal ties (Hruschka, 2010; Seyfarth & Cheney, 2012; Silk, 2003; Tooby & Cosmides, 1996). These bonds were likely favored because they provided forms of support and cooperation that helped individuals address key adaptive challenges, including physical protection, forming alliances, accessing resources, and securing mating opportunities (Bleske-Rechek & Buss, 2001; DeScioli, Kurzban, Koch, & Liben-Nowell, 2011; Lewis et al., 2011).

Given such positive friendship affordances, does making more friends produce higher well-being and a more fulfilling life? Perhaps not always. Friends also bring costs (Alexander, 1974; Kenrick, Griskevicius, Neuberg, & Schaller, 2010; Neuberg & Cottrell, 2008; Shackelford & Buss, 1996; Williams, Krems, Ayers, & Rankin, 2022). These include significant resource strain, as one must distribute time, money, and emotional support across many individuals; increased vulnerability to free-riding and betrayal, where others may exploit one's contributions; and more social obligations, which may interfere with pursuing other fitness-enhancing goals. Among these costs, a less studied but critical influence on health and sociality is increased risk of exposure to germs and non-zoonotic infectious diseases (those capable of human-to-human transmission). Making and maintaining a large, interconnected affiliative group requires more interpersonal interaction than maintaining a smaller group (Farrell, Stanton, & Marshall, 2022; Fu, 2005; House, Umberson, & Landis, 1988), leading to a higher risk of pathogen transmission (in humans: Christley et al., 2005; Meyers, Pourbohloul, Newman, Skowronski, & Brunham, 2005; Pérez-Ortiz et al., 2022; and in

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non-human animals: Rifkin et al., 2012; Siracusa et al., 2024). The impact of pathogen transmission can be substantial, ranging from income loss to disability to premature mortality to global pandemics. In the current paper, we consider how people balance the benefits of friendships with their potential health risks and examine whether this balance differs by individual differences in sensitivity to pathogenic threats.

1.1. Conflict between disease avoidance and social affiliation

Psychological mechanisms that aid in infection prevention, including those associated with management of social relationships, are collectively represented by the *behavioral immune system* (Ackerman, Hill, & Murray, 2018; Schaller & Park, 2011). Compared to the biological immune system, the behavioral immune system offers a unique adaptive advantage by preemptively defending against external infectious agents. These agents are often transmitted interpersonally, creating conflict between interpersonal affiliation and disease avoidance motivations. Research addressing these dual motives has focused on how disease concerns downregulate affiliative motives toward novel others, and vice versa (Murray & Schaller, 2016; Neuberg, Kenrick, & Schaller, 2011). On one hand, disease concerns decrease the desire for social interaction through seeking less company (Mortensen, Vaughn Becker, Ackerman, Neuberg, & Kenrick, 2010; Ren et al., 2023; Sacco, Young, & Hugenberg, 2014) and reduced willingness to trust unknown individuals (Aarøe, Osmundsen, & Petersen, 2016). On the other hand, active affiliative motives can diminish disease avoidance tendencies (Sacco et al., 2014).

The extent to which individuals experience this motivational conflict varies. Particularly relevant to this variation may be subjective sensitivity to infection risk, a trait (or collection of traits) exhibiting substantial between-person differences and within-person consistency (Duncan, Schaller, & Park, 2009; Tybur, Lieberman, & Griskevicius, 2009). A recent study by Nunner, Buskens, Corten, Kaandorp, and Kretzschmar (2023) showed that highly risk-averse individuals prioritized disease avoidance over forming new (artificial) relationships, consistently avoiding infected individuals and even those who had close social contact with infected people, whereas less risk-averse individuals were more willing to maintain or establish social relations, despite a risk of infection. If such patterns persist over time, they may shape the size and composition of real social networks, such that individuals who are highly averse to infection risk may maintain relatively smaller friendship networks.

1.2. Harmony between disease avoidance and social affiliation

Though motivational conflict has received the bulk of empirical attention, complementarity is possible as well. Affiliation and disease avoidance are both considered fundamental, universally valued motives (Kenrick et al., 2010; Pick et al., 2022), making their associated goals (e.g., maintaining personal health, sustaining friendship networks) crucial for physical and mental well-being, with studies highlighting the importance of balancing these objectives (Boudreaux & Ozer, 2013; Emmons & King, 1988; Kung & Scholer, 2020). When considering the role of friends, these motives may even be mutually beneficial. The literature examining disease avoidance-affiliation conflict has mostly focused on interactions involving strangers in zero-acquaintance situations. Unlike strangers, friends involve pre-existing relationships with an established degree of psychological closeness, trust, and prosocial expectations (Sprecher & Regan, 2002; Wiseman, 1986). These processes can aid the pathogen avoidance functions of the behavioral immune system. Friends can promote healthier behaviors, better self-care, and reduced risk-taking (Cohen & Wills, 1985; Gershon, Cryder, & Milkman, 2024; Thoits, 2011). For example, having more close friends is linked to greater adoption of infection prevention behaviors (e.g., handwashing, using paper instead of cloth), and having more acquaintances is associated with increased informational support (Steijvers et al., 2021). If individuals do become infected, friends can aid recovery by providing instrumental and emotional support (Apostolou, Keramari, Kagialis, & Sullman, 2021; Cottrell, Neuberg, & Li, 2007; Hall, 2012; Sugiyama, 2004). Close friends are especially relevant for offering significant assistance as well as expressing less aversiveness to the illnesses of highly valued others (Tybur, Lieberman, Fan, Kupfer, & de Vries, 2020).

Conversely, better health and hygiene could improve social opportunities. Chronically germ-averse individuals tend to be relatively concerned about, and prefer spending money to improve, their appearance (e.g., purchasing cosmetics, taking diet pills), likely due to desires to appear healthy and be liked (Ackerman et al., 2018). Healthy and physically fit individuals are often considered desirable social partners, whereas those with poor hygiene are often avoided (Cottrell et al., 2007; Curtis & Biran, 2001; Speltini & Passini, 2014). Thus, a reciprocal relationship may exist where having more friends promotes better health behaviors, and better health and hygiene, in turn, support social connection goals.

1.3. Layers of friendship

These considerations about the conflict and harmony between disease avoidance and social affiliation suggest that, in the context of pathogen threat, friendships entail a distinct balance of costs and benefits compared with those involving strangers or mere acquaintances. As a result, individuals who are more sensitive to pathogenic threats may form and maintain fewer friendships overall than those who are less sensitive. However, this association is unlikely to be uniform across layers of friends. Friendships tend to be organized in hierarchically inclusive layers (or circles) that range from best friends to more casual acquaintances, with each successive circle containing more individuals but lower levels of contact and emotional closeness (Dunbar, 1998; Dunbar, 2018; Hill & Dunbar, 2003; Sutcliffe, Dunbar, Binder, & Arrow, 2012). The benefits associated with close, inner-circle friendships, such as food and instrumental support when sick, (Gurven, Allen-Arave, Hill, & Hurtado, 2000; Sugiyama, 2004) as well as emotional, informational, and alliance-based support more generally (Krems, Hahnel-Peeters, Merrie, Williams, & Sznycer, 2023; Sias & Bartoo, 2007), are substantial and may outweigh pathogen concerns even for those who are chronically germ-averse. Consistent with this view, pathogen-avoidance tendencies tend to be relaxed in close relationships: people report less disgust and greater tolerance toward disease cues in highly valued others (Tybur et al., 2020). By contrast, as friendships extend into less intimate circles that resemble acquaintances, the marginal benefits of each additional tie become more uncertain while the cumulative costs grow (Hruschka, 2010; Tsang, Barrentine, Chadha, Oishi, & Wood, 2025), leaving more room for individual differences in germ aversion to influence friendship decisions. Consequently, individual differences in germ aversion may be expressed most strongly in the pruning of outer friendship circles, while leaving inner circles relatively unaffected.

Such friendship decisions may also have downstream implications for subjective well-being. While a sense of well-being is not an adaptive goal in itself, it can function as a proximate signal that tracks progress toward evolutionarily relevant goals and reflects individual differences in the prioritization of fundamental motives (Buss, 2000; Diener, Kanazawa, Suh, & Oishi, 2015; Grinde, 2002; Kenrick & Krems, 2018; Kurzban & Aktipis, 2007; Nesse, 2004; Nesse, 2019). That is, individuals may experience heightened subjective well-being when their motives for both disease avoidance and social affiliation are satisfied to the extent they desire, and when these motives are aligned in ways that facilitate success in enhancing fitness.

1.4. Current research

Across four studies, we examined how and why chronic individual differences in infection risk concern are associated with the size and structure of friendship networks. We hypothesized that people relatively

high in germ aversion would have smaller friendship networks overall, with especially pronounced differences in their outer, less intimate circles (Studies 1a and 1b). We expected that such networks would foster stronger connections but also necessitate higher expectations from those friends (Study 2). In other words, individuals high in germ aversion would be more likely to focus their time and energy on close friends, rather than spreading them across many acquaintances, reflecting a "narrow and deep" social strategy (Oishi & Kesebir, 2012; Tsang et al., 2025; see Table 1 for effects across studies). We further predicted that experimentally manipulating views about goal harmony (versus conflict) between disease avoidance and friendship would have positive psychological consequences, including sense of well-being (Study 3). This effect may be most pronounced for those chronically high in germ aversion, who are especially likely to be attuned to the disease-relevant costs of friendships.

To assess infection sensitivity, we focused on germ aversion, a subscale of the perceived vulnerability to disease (PVD) measure, which emphasizes outward vigilance and affective responsivity toward potential sources of infection (Duncan et al., 2009). PVD is the most widely used index of chronic pathogen concerns in the psychology of infection (or behavioral immune system) literature (e.g., Huang, Sedlovskaya, Ackerman, & Bargh, 2011; Miller & Maner, 2012; Oosterhoff, Shook, & Iyer, 2018). Additionally, we analyzed the following: (1) in a pilot study (see Supplement), the perceived infectability subscale of PVD (which, unlike germ aversion, was not associated with friend network size), (2) in Study 2, disgust sensitivity, a construct conceptually related to germ aversion, and (3) in Studies 1a and 2, objective pathogen threat, as measured by county-level mortality rates due to infectious diseases. Across studies, bivariate correlations between all key variables are reported in the Supplement.

All main studies were preregistered, and materials, data, code, and preregistrations are available on the Open Science Framework (https://doi.org/10.17605/OSF.IO/RN6B4).

All studies were approved by the university's Institutional Review Board.

2. Study 1a: Friendship network size

2.1. Method

2.1.1. Participants

After applying exclusion criteria, 316 U.S. participants recruited through Prolific Academic became a final sample of 308 participants. This sample size provided 80 % power at a significance level of $\alpha = 0.05$ to detect a small effect size of $f^2 = 0.03$ in a linear regression analysis. Participants were 38.98 years old on average ($SD = 13.70$), 58 % female (178 women, 119 men, 2 transgender women, 2 transgender men, 6 other, 1 unknown), and approximately 33 % of the participants were non-White.

2.1.2. Procedure

Participants were presented with a friend definition: someone with whom participants intentionally maintain contact, excluding family members and romantic partners. Participants viewed the concept of friendship circles (adapted from Hill & Dunbar, 2003; Sutcliffe et al., 2012; see Fig. 1 and Supplement), featuring four concentric circles, each reflecting different levels of emotional closeness and contact frequency: (a) Best Friends, contacted at least weekly for strong emotional or practical support; (b) Close Friends, contacted at least monthly for regular emotional support; (c) Casual Friends, contacted a few times per year, primarily in social or group contexts; and (d) Meaningful Contacts or Acquaintances, contacted at least annually for practical or social networking purposes. Participants reported the number of friends within each circle and listed their friends' first names and last initials (up to 30 per circle). They were encouraged to look through their phone contacts, email lists, address books, or social media to aid their memory.

Next, participants completed individual difference measures, including germ aversion (e.g., "It really bothers me when people sneeze without covering their mouths."; $\alpha = 0.77$). Participants also responded to items assessing disease avoidance value (reported in the Supplement), completed the Ten-Item Personality Inventory (TIPI; Gosling, Rentfrow, & Swann, 2003), and provided demographic information.

Using participants' residential zip codes, we linked county-level

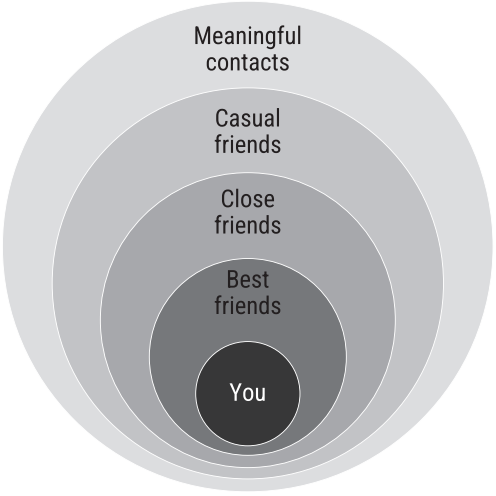

Fig. 1. Depiction of friendship circles.

Table 1
Germ aversion and friendship circles across studies.

	N	Total friends	Best friends	Close friends	Casual friends	Meaningful contacts
Primary studies						
Study 1a: United States	308	−0.13 [−0.24, −0.02]	−0.10 [−0.24, 0.04]	−0.10 [−0.25, 0.04]	−0.16 [−0.31, −0.02]	−0.16 [−0.30, −0.01]
Study 1b: Cross-cultural	1202	−0.12 [−0.20, −0.03]	−0.01 [−0.13, 0.12]	−0.07 [−0.20, 0.05]	−0.16 [−0.28, −0.04]	−0.23 [−0.35, −0.11]
Study 2	323	−0.25 [−0.36, −0.14]	−0.11 [−0.25, 0.03]	−0.19 [−0.33, −0.05]	−0.27 [−0.41, −0.13]	−0.42 [−0.57, −0.28]
Supplemental studies						
Study S1: College sample	223	−0.23 [−0.44, −0.03]	−0.15 [−0.42, 0.12]	−0.18 [−0.45, 0.09]	−0.26 [−0.53, 0.01]	−0.34 [−0.61, −0.07]
Study S2: Cross-relationship comparison	506	−0.16 [−0.23, −0.09]	−0.05 [−0.15, 0.05]	−0.09 [−0.19, 0.01]	−0.20 [−0.29, −0.10]	−0.30 [−0.39, −0.20]

Note. Values are unstandardized regression coefficients (b) with 95 % confidence intervals from linear mixed-effects models. Models included germ aversion (person-level), friendship circle (within-person), and their interaction, with random intercepts for participants. The total friends column reports the main effect of germ aversion on the square-root-transformed number of friends; the other columns report the simple slopes of germ aversion at each friendship circle.

infectious disease-related mortality data from the Centers for Disease Control and Prevention (2025) WONDER Online Database as part of a preregistered exploratory analysis of objective pathogen threat. This dataset has been used in prior work to capture regional variation in parasite stress (Atari et al., 2022; Mullett, Brown, Fincher, Kosinski, & Stillwell, 2020). Including these data allowed us to examine whether actual pathogen threat predicts differences in friendship networks as a contextual factor. We compiled archival data spanning from 1979 to 2023, mapping infectious diseases using the 9th and 10th revisions of the International Classification of Diseases (based on el Bcheraoui et al., 2018), and indexed the crude mortality rate (per 100,000 residents) due to infectious diseases for each county across this period. Participants in our sample resided across 206 unique counties, with a mean mortality rate of 31.46 ($SD = 9.00$).

2.2. Results

Consistent with prior friendship literature, distributions of the circles were positively skewed (Skewness = 1.91, 2.80, 3.11, 4.62; Kurtosis = 6.05, 11.30, 12.94, 26.42, respectively). Following methods commonly employed in social network research (e.g., Kilduff, Crossland, Tsai, & Krackhardt, 2008; Oishi et al., 2013) and in accordance with our preregistration plan, we winsorized friend numbers to adjust for extreme outliers. Specifically, values greater than three standard deviations above or below the mean were adjusted to the three-standard-deviation value. We repeated this process using a two-standard-deviation criterion. Then, we applied a square-root transformation.

As expected based on prior social network research (Dunbar, 1998; Hill & Dunbar, 2003), people listed fewer friends in the inner layers than in the outer layers, with each layer significantly smaller than the one immediately outside it. On average, participants reported 1.87 best friends ($SD = 1.71$), 3.50 close friends ($SD = 3.60$), 6.67 casual friends ($SD = 7.97$), and 12.11 meaningful contacts ($SD = 22.93$). For initials, they listed averages of 2.10 ($SD = 2.48$) for best friends, 2.93 ($SD = 2.53$) for close friends, 4.63 ($SD = 4.70$) for casual friends, and 5.17 ($SD = 6.34$) for meaningful contacts.

2.2.1. Association with germ aversion

To examine the effect of germ aversion on friendship, we fit a linear mixed-effects (multilevel) model with observations nested within participants, including fixed effects of germ aversion (person-level), friendship circle (within-person; ordered), and their cross-level interaction, with random intercepts for participants. Although our preregistration specified separate linear regression analyses for each friendship circle, we updated this plan to use a multilevel approach because it provides a more appropriate test of both between- and within-person components and was also recommended during peer review (the same adjustments were made for Studies 1b and 2). The preregistered analyses are reported in the Supplement. The overall pattern of results is similar across analytic approaches, with some variation in the strength of effects across circles.

Consistent with our prediction, individuals higher in germ aversion reported fewer friends overall than those lower in germ aversion, $b = -0.13$, $t(307) = -2.32$, $p = .021$. The interaction between germ aversion and friendship circle was not significant, $b = -0.05$, $t(916) = -0.92$, $p = .358$, indicating a broadly similar negative association across circles. Simple slopes nonetheless indicated that this association was descriptively stronger for more outer circles. For the inner two circles (best and close friends), the slopes were negative but nonsignificant, $b = -0.10$, $p = .175$ and $b = -0.10$, $p = .163$, respectively. For the outer two circles (casual friends and meaningful contacts), the slopes were significantly negative, $b = -0.16$, $p = .028$ and $b = -0.16$, $p = .036$, respectively. That is, individuals higher in germ aversion tended to report fewer friends overall, with this pattern appearing somewhat stronger in the outer circles, although differences between circles did not reach significance.

As an exploratory analysis, we tested the effect of germ aversion controlling for extraversion and demographics, including age, gender, relationship status, and education (all centered), factors previously found to be relevant to social network size. The same covariates were used in all other studies, except for Studies 1b and 3, where we used socioeconomic status (SES) instead of education, as SES captures a fuller picture of participants' social and economic standing beyond education. Generally, larger social networks are associated with more extraverted individuals, women more than men, young adults, those in uncommitted relationships, and individuals with higher education or socioeconomic status (Ajrouch, Hu, Webster, & Antonucci, 2024; Wrzus, Hänel, Wagner, & Neyer, 2013). When these factors were included, the effect of germ aversion was no longer significant, though it followed the same directional trend. Significant covariates included extraversion and higher education, with more extraverted individuals, $b = 0.23$, $p < .001$, and those with a university degree or higher, $b = 0.25$, $p = .038$, having more friends overall. To further probe this change, and consistent with our exploratory preregistered analysis, we parsed germ aversion into two components: feelings of disgust and behavioral intention (Kitayama, Salvador, & Ackerman, 2023). Feelings of disgust, reflecting affective responses such as anxiety and disgust, remained a significant predictor of the number of friends after accounting for the covariates, $b = -0.11$, $t(287) = -2.09$, $p = .038$, driven by a significant effect for meaningful contacts, $b = -0.18$, $p = .012$ and a marginal effect for casual friends, $b = -0.12$, $p = .096$. In contrast, behavioral intention, reflecting habits aimed at avoiding germs, was not a significant predictor once covariates were included.

2.2.2. Accounting for objective pathogen threat

In line with a preregistered exploratory hypothesis, we examined whether individual differences in the friendship circles could be accounted for by objective pathogen threat, beyond subjective infection concerns. Because the modal sample size per county was one, county could not be treated as a meaningful multilevel grouping factor, so we included county-level mortality rates as an individual-level contextual predictor. Including the mortality index in the main model revealed no significant main effect on number of friends, $p = .571$. Individual-level germ aversion continued to predict friendship network size independently of county-level mortality rates, $b = -0.13$, $t(299) = -2.30$, $p = .022$, again driven primarily by effects for casual friends, $b = -0.17$, $p = .024$, and meaningful contacts, $b = -0.16$, $p = .038$. Thus, individual perceptions appear to be more influential in shaping friendship patterns than this index of external pathogen threat.

2.3. Discussion

As hypothesized, a consistent negative association was observed between germ aversion and number of friends, whether measured by the reported number of friends or the count of friends' initials. Notably, these associations remained stable irrespective of an objective indicator of pathogen threat. This preference for smaller friendship circles likely reflects an adaptive trade-off between disease avoidance and social affiliation motives, with more germ-averse individuals prioritizing the former. In the next study, we investigated whether this pattern holds beyond the United States.

3. Study 1b: cross-cultural patterns

Does the association between chronic germ aversion and friendship network size generalize across different cultural contexts? We preregistered a hypothesis of cross-cultural consistency, such that individuals with higher levels of germ aversion would maintain smaller, more close-knit friendship networks, whereas individuals with lower aversion would maintain larger, more loosely connected networks. Six target countries were chosen to represent different world regions, feature relatively high English proficiency, and to maximize participant

recruitment likelihood.

3.1. Method

3.1.1. Participants

Participants were recruited through BeSample, an online platform specifically designed for non-WEIRD research. Although our preregistered target was 200 participants per country, actual recruitment slightly exceeded this goal due to simultaneous enrollment across locations. We recruited a total of 1312 participants: 239 from Brazil, 202 from Germany, 205 from Ghana, 219 from India, 205 from Kenya, and 242 from the Philippines. After applying preregistered exclusion criteria (including short survey completion duration, nonsensical open-ended responses, and insufficient English proficiency) and excluding participants whose geolocation data didn't match the recruitment site, the final sample consisted of 1202 participants: 200 from Brazil, 200 from Germany, 197 from Ghana, 201 from India, 194 from Kenya, and 210 from the Philippines. Participants were 31.87 years old on average (SD = 10.42), 40 % female (481 women, 702 men, 1 transgender woman, 3 transgender men, 8 other, 6 unknown). Country-specific demographic information is provided in the Supplement.

3.1.2. Procedure

The procedure for Study 1b was largely identical to that of Study 1a except that participants reported only the number of friends within each of the four friendship circles without providing friends' initials. As in Study 1a, the reported numbers of friends were winsorized and square-root transformed separately for each country.

3.2. Results

Although participants were nested within countries, our number of level-two units (six countries) was too small for robust multilevel modeling, as it falls well below the recommended minimum (20–30 clusters) for reliable variance estimation and model convergence (Maas & Hox, 2005; Snijders & Bosker, 2012). We therefore treated country as a fixed factor and fitted a mixed linear regression with a random intercept for participant, predicting the number of friends reported in each circle from centered individual-level germ aversion, friendship circle, country (effect-coded into six levels), and all interactions. Results from an exploratory multilevel model with random intercepts and slopes for germ aversion at the country level, instead of treating country as a fixed factor, are reported in the Supplement.

Across countries, individuals higher (vs. lower) in germ aversion reported having fewer friends overall, $b = -0.12$, $t(1173) = -2.70$, $p = .007$. This main effect was qualified by an interaction with friendship circles, $b = -0.17$, $t(3516) = -3.25$, $p = .001$, showing that the negative association between germ aversion and friendship size grew stronger from inner to outer circles. Interactions between germ aversion and country were generally small and nonsignificant (all $ps > 0.05$). Most three-way interactions among germ aversion, friendship circle, and country were also nonsignificant, with the exception of two terms involving Ghana and India (ps = 0.041 and 0.026), which indicated some country-specific deviations within an otherwise consistent pattern across the six countries. To probe these effects, we examined simple slopes of germ aversion within each friendship circle and country (see Table 2). In Brazil, Germany, and Ghana, higher germ aversion was significantly associated with having fewer meaningful contacts, and in Ghana and the Philippines there were marginally negative associations for casual friends. In contrast, slopes for best and close friends were small and non-significant in all countries, and in India and Kenya germ aversion was not significantly related to the size of any friendship circle. Unlike Study 1a, these effects remained when extraversion and demographic covariates were added to the model, and the two facets of germ aversion (feelings of disgust and behavioral intention) had similar effects (see Supplement).

3.3. Discussion

The findings from Study 1b revealed a general cross-cultural pattern, with higher germ aversion associated with smaller friendship networks across the six countries, particularly in the outer circles. However, the strength of these associations varied by country, with Germany, Brazil, and Ghana, and to a lesser extent the Philippines, most closely mirroring the relationship previously observed with U.S. participants in Study 1a. Associations observed elsewhere were weaker, suggesting possible cultural or ecological moderators that merit future investigation. In the following studies, we returned to the U.S. context, aiming to replicate and further explore the underlying mechanisms driving these observed relationships.

4. Study 2: Friendship beliefs and standards

Why might germ-averse individuals have fewer friends? We have focused on tradeoffs between anti-pathogen and pro-social motivations, consistent with literature outside the domain of friendship. Germ-averse people may feel compelled to limit their social interactions to reduce their risk of infection exposure, leading to smaller networks out of perceived necessity. Alternatively, these people may choose to maintain smaller social circles out of preference, perhaps valuing the intimacy of close-knit groups (Adams & Plaut, 2003; Oishi & Kesebir, 2012). The key question is whether network size is derived from perceived needs associated with germ aversion (reflected in an *ought* social network) or due to disease-irrelevant preferences (reflected in an *ideal* social network). Of course, these possibilities are not necessarily mutually exclusive, as both perceived needs and desires can shape friendships.

A second question involves the standards (characteristics and qualities) preferred for friends: Germ-averse individuals, being more sensitive to the tradeoff between disease avoidance and social affiliation, might seek friends who help mitigate this tradeoff by selecting friends based on specific characteristics that reduce germ exposure risk, such as good health, high hygiene values, or access to resources that promote cleanliness. Additionally, germ-averse individuals might prioritize the type of support friends can offer, especially in times of illness. This

Table 2
Germ aversion and friendship network associations by country.

	Best friends			Close friends			Casual friends			Meaningful contacts		
	b	*t*	*p*	*b*	*t*	*p*	*b*	*t*	*p*	*b*	*t*	*p*
Germany	−0.08	−0.52	0.61	−0.16	−1.10	0.27	−0.22	−1.44	0.15	−0.39	−2.62	0.01
Brazil	−0.01	−0.06	0.95	−0.16	−1.03	0.30	−0.22	−1.43	0.15	−0.49	−3.18	0.00
Ghana	0.01	0.07	0.95	−0.03	−0.22	0.83	−0.27	−1.84	0.07	−0.51	−3.42	0.00
Philippines	−0.05	−0.30	0.76	−0.13	−0.82	0.41	−0.27	−1.76	0.08	−0.19	−1.22	0.22
Kenya	0.08	0.61	0.54	0.05	0.33	0.74	0.03	0.22	0.83	0.03	0.19	0.85
India	0.00	0.00	0.99	0.00	−0.01	0.99	0.00	−0.02	0.98	0.18	1.02	0.31

Note. Values represent unstandardized regression coefficients, t-statistics, and significance levels from simple slopes of a mixed linear regression predicting the number of friends reported in each circle from germ aversion, friendship circle, country, and all interactions.

support could be instrumental, such as helping with tasks when one is sick, or emotional, such as providing comfort and reassurance. By using more stringent standards for friendships, germ-averse individuals may compensate for having smaller social networks by ensuring that their existing friends offer sufficient and reliable support.

Thus, we preregistered the hypothesis that individuals who are more averse to germs and infectious diseases are more likely to maintain a small, close-knit network of friends rather than a wide, casual network, with stronger differences in the outer circles (replicating the finding from Studies 1a and 1b). We compared their actual networks with their ought and ideal networks to help reveal the mental framing germ-averse people apply to friends. We predicted that these individuals would have higher standards for defining someone as a friend.

4.1. Method

4.1.1. Participants

We recruited 336 U.S. participants from Prolific Academic, with 323 left after applying preregistered exclusion criteria. This sample afforded 80 % power at a significance level of $\alpha = 0.05$ to detect a small effect size of $f^2 = 0.03$ in a linear regression analysis. Participants were 41.22 years old on average (SD = 14.06), 65 % female (209 women, 102 men, 2 transgender men, 9 other, 1 unknown), and approximately 40 % of the participants were non-White.

4.1.2. Procedure

Participants read descriptions of four layers of friendship and then indicated the number of friends in each layer that they: actually had (actual network), believe they should have (ought network), and ideally would like to have (ideal network). The actual network instruction was identical to Studies 1a and 1b. The ought network involved the number of friends they believed they should or ought to have considering their specific health circumstances. The ideal network involved the number of friends they would ideally like to have irrespective of personal or external limitations (see Supplement for details).

Next, participants completed four subscales of the Friendship Standards scale, which assesses individuals' expectations for an ideal friend (Hall, 2012): agency (what a friend can do, has access to, and is able to offer; α = 0.95), similarity (in attitudes and interests; α = 0.85), instrumental support (assistance and favor granting; α = 0.89), and communion (emotional availability and self-disclosure; α = 0.89; 1 = *not important at all*, 7 = *absolutely essential*). Participants also indicated how high their standards generally are for someone to be considered as a friend (1 = *very low standards*, 7 = *very high standards*) and how flexible they believe their standards are for friendships (1 = *completely fixed*, 7 = *very flexible*). Additionally, participants completed the Interpersonal Support Evaluation List (α = 0.92; Cohen, Mermelstein, Kamarck, & Hoberman, 1985), which measures perceived availability of three types of social support in their current friendship network: appraisal (e.g., "When I need suggestions on how to deal with a personal problem, I know someone I can turn to."; α = 0.85), belonging (e.g., "If I wanted to have lunch with someone, I could easily find someone to join me."; α = 0.84), and tangible social support (e.g., "If I were sick, I could easily find someone to help me with my daily chores."; α = 0.77; 1 = *definitely true*, 4 = *definitely false*).

Again, our key predictor of interest was germ aversion (α = 0.74; Duncan et al., 2009). Following the Study 1a finding that the feelings of disgust subscale in germ aversion was more strongly related to number of friends than was the behavioral intentions subscale, we also added the pathogen sensitivity subscale of the Three-Domain Disgust Scale, which assesses disgust responses to stimuli associated with pathogen cues (α = 0.81; Tybur et al., 2009). Although germ aversion and disgust sensitivity tap somewhat distinct mental processes, both reflect an investment in pathogen avoidance. Lastly, participants completed the Ten-Item Personality Inventory (Gosling et al., 2003) and responded to demographic questions, including residential zip codes used to match participants to county-level infectious disease mortality rates following the procedure described in Study 1a.

4.2. Results

4.2.1. Actual, ought, and ideal friendship networks

Similar to Study 1a, participants reported having, on average, approximately 2 best friends, 4 close friends, 9 casual friends, and 14 meaningful contacts or acquaintances (M = 28.90, SD = 33.45; see Table 3). The total number of friends reported for ought networks (M = 32.18, SD = 32.73) did not differ significantly from the actual network numbers; however, ought numbers were significantly higher for the two inner circles. The total number of friends reported for ideal friendship networks (M = 42.35, SD = 53.90) was significantly higher than participants' actual network numbers, $t(533) = 3.79$, $p < .001$, 95 % CI = [6.47, 20.42], and this was consistent across friendship circles except with casual friends.

4.2.2. Association with germ aversion and pathogen disgust

Numbers of friends in the actual, ought, and ideal networks were positively skewed and thus were square root transformed. A linear mixed-effects model including germ aversion (person-level), friendship circle (within-person; ordered), their interaction, and random intercepts for participants showed that individuals higher in germ aversion were more likely to have fewer *actual* friends in general than those lower in germ aversion, $b = -0.25$, $t(321) = -4.55$, $p < .001$. This pattern was stronger for outer circles than for inner circles, as indicated by the significant interaction between germ aversion and friendship circle, $b = -0.23$, $t(960) = -4.08$, $p < .001$. Germ aversion was not significantly related to the number of best friends, $b = -0.11$, $p = .137$, but the association became stronger for close friends, $b = -0.19$, $p = .009$, casual friends, $b = -0.27$, $p < .001$, and meaningful contacts, $b = -0.42$, $p < .001$ (see Fig. 2). As an exploratory analysis, these results held after controlling for extraversion and demographic factors. Unlike Study 1a, the results did not differ between the two facets of germ aversion (feelings of disgust and behavioral intention) regardless of whether covariates were included.

For *ought* friendship networks, individuals higher in germ aversion believed they should have relatively fewer friends overall when considering health-related needs and circumstances, $b = -0.14$, $t(324) = -2.53$, $p = .012$. A significant interaction between germ aversion and friendship circle, $b = -0.16$, $t(964) = -3.13$, $p = .002$, indicated that compared to those lower in germ aversion, they believed they should have fewer friends, particularly in the outer circles of meaningful contacts, $b = -0.29$, $p < .001$, and (marginally) casual friends, $b = -0.12$, $p = .078$, but not in the inner circles of best or close friends, $ps > 0.05$. Including covariates produced a similar pattern, with germ aversion significantly predicting only the ought number of meaningful contacts, $b = -0.23$, $p = .001$.

For *ideal* friendship networks, individuals higher in germ aversion desired fewer friends overall compared to those lower in germ aversion, $b = -0.19$, $t(325) = -2.99$, $p = .003$. Similar to the ought network, the effects were stronger in the outer circles, $b = -0.20$, $t(966) = -3.13$, $p = .002$, in which they reported a preference for fewer meaningful contacts, $b = -0.39$, $p < .001$, but not fewer best, close, or casual friends, $ps > 0.05$. These results remained consistent regardless of whether covariates were included.

Thus, across ought and ideal networks, germ aversion was consistently associated with a belief that one should maintain fewer friendships and with a preference for fewer friends, with these effects more pronounced for outer circles of friends who were less emotionally close and less frequently in contact. We also tested the same hypotheses with pathogen disgust as the predictor (this was moderately correlated with germ aversion at $r = 0.48$, $p < .001$). Results showed a pattern similar to those obtained with germ aversion (see Supplement).

Table 3
Actual, ought, and ideal friendship networks.

Friendship circle	Actual		Ought			Ideal		
	M	*SD*	*M*	*SD*	*D*	*M*	*SD*	*D*
Best friends	1.97^{a}	1.47	2.59^{c}	1.68	0.63	2.89^{b}	1.92	0.92
Close friends	4.06^{a}	3.90	5.01^{c}	4.14	0.93	5.87^{b}	5.06	1.79
Casual friends	9.12^{ab}	14.09	8.98^{b}	10.34	−0.14	11.13^{a}	13.89	2.01
Meaningful contacts	13.99^{a}	20.56	15.54^{a}	20.64	1.55	22.35^{b}	38.42	8.35

Note. For each friendship circle (rows), unmatched superscripts denote that means across networks were significantly different (at least $p < .05$). *D* refers to the discrepancy from the actual number of friends, calculated by subtracting the actual number from the ought and ideal numbers.

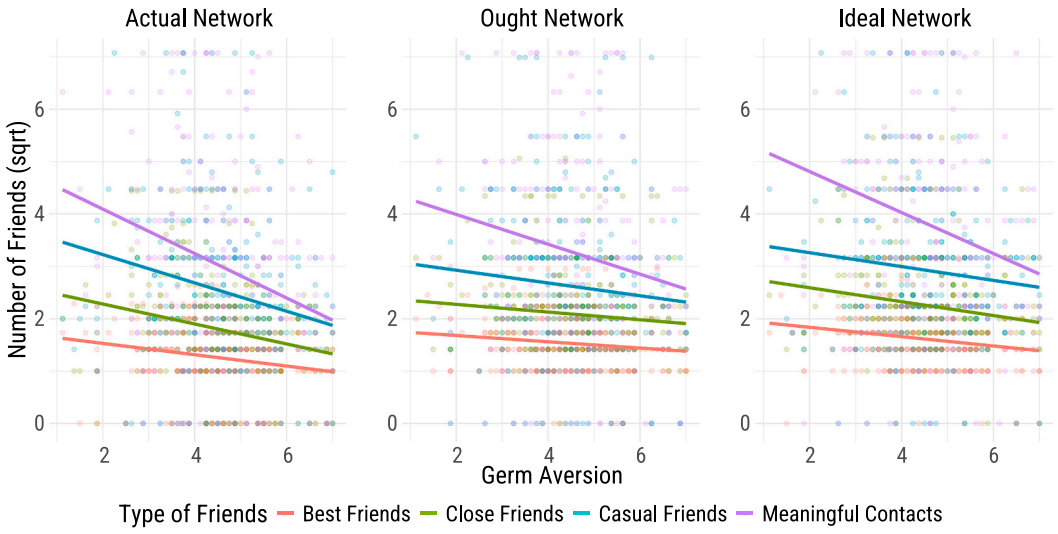

Fig. 2. Actual, ought, and ideal friendship network predicted by germ aversion.
Note. Number of friends on the y-axis is square-rooted.

4.2.2.1. Ought-actual and ideal-actual friendship discrepancies. Though individuals higher in germ aversion believed they ought (needed) to have and preferred (desired) fewer friends, their actual social networks did not always align with these opinions. To examine these mismatches, we computed ought-actual discrepancy scores for each friendship circle by subtracting actual number of friends from ought number of friends (see Table 3).

A linear mixed-effects model revealed that germ aversion significantly predicted overall ought-actual discrepancies, $b = 0.12$, $t(323) = 2.68$, $p = .007$. The effect of germ aversion did not vary significantly across friendship circles, $p = .189$. Simple slopes indicated significant effects for all circles except for the innermost one: best friends, $b = 0.05$, $p = .422$, close friends, $b = 0.13$, $p = .034$, casual friends, $b = 0.17$, $p = .006$, and meaningful contacts, $b = 0.13$, $p = .003$. The inclusion of covariates produced the same patterns of significance. That is, while germ-averse individuals believed they ought to have relatively fewer friends due to health concerns, their actual friendships still fell below these perceived needs.

A weaker pattern emerged for ideal-actual discrepancies, calculated by subtracting actual number of friends from ideal number of friends. Germ aversion did not significantly predict overall ideal-actual discrepancies, $b = 0.07$, $t(323) = 1.54$, $p = .123$. It predicted discrepancies in the number of casual friends, $b = 0.15$, $p = .010$, but not in the other circles, $ps > 0.05$. When covariates were included, the pattern of results remained unchanged. These findings suggest that germ-averse individuals prefer to maintain fewer friends than less germ-averse individuals, and although their ideal and actual network sizes generally align, they show a somewhat larger gap for casual friendships.

4.2.3. Accounting for objective pathogen threat

We included county-level mortality rates from infectious diseases (204 counties, $M = 30.93$, $SD = 10.95$) as a contextual covariate in the linear mixed-effects models to predict actual, ought, and ideal friendship networks. Similar to the earlier findings, results for actual friendship networks showed consistent negative effects of individual-level germ aversion on the number of friends, $b = -0.25$, $t(305) = -4.45$, $p < .001$. The effects were stronger in the outer circles, $b = -0.24$, $t(915) = -4.16$, $p < .001$, including close friends, $b = -0.19$, $p = .013$, casual friends, $b = -0.27$, $p < .001$, and meaningful contacts, $b = -0.43$, $p < .001$, but were not significant for best friends. However, county-level mortality rates were not significant predictors for any friendship circle, all $ps > 0.05$. The same pattern emerged for ought and ideal networks: individual germ aversion effects persisted, with stronger effects in the outer circles, whereas county-level mortality rates remained non-significant, all $ps > 0.05$. These findings suggest that friendship network sizes are influenced primarily by subjective concerns about infection risk rather than objective measures of pathogen threat.

4.2.4. Friendship standards and support

We next examined how germ aversion influenced individuals' standards for the characteristics and qualities they value in friendships. People high in germ aversion were more likely to have higher standards for considering someone as a friend, $b = 0.14$, $t(319) = 2.34$, $p = .020$. Specifically, they held friends to higher standards on agency, $b = 0.22$, $t(321) = 2.51$, $p = .013$, similarity, $b = 0.15$, $t(321) = 3.10$, $p = .002$, and (marginally) instrumental support, $b = 0.13$, $t(321) = 1.69$, $p = .092$, but not communion. Moreover, these individuals reported that their standards for friendships were relatively more fixed, indicating less flexibility over time or across people, $b = -0.25$, $t(321) = -3.12$, $p = .002$.

Interestingly, highly germ-averse individuals reported receiving less interpersonal support from their existing friends than those lower in germ aversion, $b = -0.07$, $t(321) = -2.04$, $p = .042$. This difference was

driven solely by tangible support, with no significant differences observed in appraisal or belonging support, $b = -0.10$, $t(321) = -2.52$, $p = .012$.

When pathogen disgust was used as the predictor instead of germ aversion, the same significant effects emerged, except for communion in friendship standards, which showed a significantly positive relationship with pathogen disgust (see Supplement for statistics).

4.3. Discussion

Replicating findings from Studies 1a and 1b, the current study indicated that germ-averse (and disgust sensitive) individuals were more likely to have smaller friendship networks. Further, these smaller networks were matched by both believing that health needs obligated having fewer friends (ought network) and wanting fewer friends (ideal network). Across all network types, germ aversion was most strongly associated with negativity toward distant others (i.e., number of meaningful contacts). Despite the relatively lower desire for friends among highly germ-averse individuals in the present study, these participants tended to report that their actual number of friends fell short of their ought and ideal networks, particularly in the outer circles. It appears that greater investment in disease avoidance comes at a higher cost to social affiliation. Bolstering these conclusions, the overall patterns for actual, ought, and ideal networks were replicated in an additional study involving a younger university sample ($N = 223$; see Study S1 in the Supplement).

This tradeoff is supported by the friendship standard results. As predicted, individuals with higher germ aversion set stricter standards for friendship, prioritizing agency (what a friend can do, has access to, and can offer), similarity (in attitudes and interests), and instrumental support (assistance and favor granting), factors that potentially could either mitigate the risk of germ exposure or enhance the quality of support during illness. Despite these patterns, germ-averse people reported receiving less tangible support in the very areas where their standards were high. This discrepancy could potentially stem from their having fewer friends to provide material or instrumental help or their relatively high standards outpacing the degree of actual support received. This discrepancy also could result in a variety of negative outcomes for germ-averse individuals, a possibility we return to in the General Discussion.

5. Study 3: Motivational harmony versus conflict

In Study 3, we directly examined the tradeoff between disease avoidance and friendship affiliation motives by testing how perceived harmony or conflict between these motives affects subjective well-being. In our preregistration, we predicted that experimentally manipulating views about goal conflict (versus harmony) would negatively affect individuals' global and domain-specific sense of well-being (e.g., with health and friendships). A complementary perspective is that inducing perceptions of harmony might attenuate perceived goal conflict, fostering a greater sense of compatibility between these two goals and thereby enhancing well-being outcomes. As an exploratory prediction, we anticipated that this effect would be particularly strong for individuals high in chronic germ aversion, as they may be relatively sensitive to these tradeoffs.

5.1. Method

5.1.1. Participants

We recruited 465 U.S. participants from Prolific Academic, with 433 remaining after applying preregistered exclusion criteria. This sample allowed us to detect a small effect size of $f = 0.15$ in a one-way ANOVA at 80 % power and the alpha level at 0.05. Participants were 38.88 years old on average ($SD = 13.76$), 56 % female (243 women, 172 men, 1 transgender woman, 1 transgender man, 10 other, 6 unknown), and approximately 33 % of the participants were non-White.

5.1.2. Procedure

Participants were first given a brief explanation of the concept of goals ("something you are aiming for—your wants or needs in various aspects of life"), along with examples of life domains and corresponding goals. Participants then described their current or near-future goals in two domains, in randomized order: creating and maintaining friendships, and managing health (with an emphasis on germ and infectious disease protection).

Next, we adapted measures of goal harmony and conflict that elicit personal goals and asked participants to consider whether pursuing paired goals is easy or difficult (Emmons & King, 1988; Michalak, Heidenreich, & Hoyer, 2011). Participants were randomly assigned to one of three conditions: (1) harmony condition, where they wrote about how friendship and health goals support each other; (2) conflict-health condition, where they wrote about how health goals might interfere with achieving friendship goals; and (3) conflict-friendship condition, where they wrote about how pursuing friendship goals might interfere with health goals (see Supplement for the specific instructions). The two conflict conditions were included to test whether directional effects (e.g., activation of one goal leading to downregulation of the other) would differentially affect psychological consequences of this tradeoff.

After the manipulation, participants reported their emotional state using the Positive and Negative Affect Schedule ($\alpha = 0.85$ for positive affect and $\alpha = 0.84$ for negative affect; Watson, Clark, & Tellegen, 1988) and life satisfaction using the Satisfaction With Life Scale ($\alpha = 0.93$; Diener, Emmons, Larsen, & Griffin, 1985). Following this, they recalled aspects of the harmonious or conflicting relationship between health and friendship goals, which served as an experimental manipulation booster. They then answered questions about their satisfaction with friends ($\alpha = 0.90$) and health ($\alpha = 0.87$). This approach helped us determine whether the experimental manipulations influenced global life satisfaction or were specific to the domains of perceived harmony or conflict. This distinction is important because, as noted by Oishi, Diener, Suh, and Lucas (1999) and Rojas (2006), considerable individual differences exist in how various life domains are weighed in overall life satisfaction judgments. Finally, participants completed assessments of loneliness ($\alpha = 0.89$; Hughes, Waite, Hawkley, & Cacioppo, 2004; Russell, 1996), preference for friendship network size (1 = *broad and casual*, 7 = *narrow and deep*; reverse-coded; Kim & Suh, 2024), germ aversion ($\alpha = 0.74$; Duncan et al., 2009), personality traits (Gosling et al., 2003), and demographic information, followed by a debrief.

5.2. Results

As preliminary analyses, we examined the relationship between individuals' chronic levels of germ aversion and the social and health-related measures, while including goal condition as a covariate. Consistent with earlier studies, individuals with higher levels of germ aversion showed a preference for a small and deep friendship network over a broad and casual one, $b = -0.12$, $t(431) = -2.12$, $p = .034$, compared to those with lower levels of germ aversion.

Additionally, individuals higher in germ aversion reported significantly lower satisfaction with their health compared to those lower in germ aversion, $b = -0.20$, $t(431) = -3.25$, $p = .001$. Consistent with the finding in Study 2, those who were less satisfied with their current friendship networks also reported lower satisfaction with their health status, $r(431) = 0.37$, $p < .001$.

5.2.1. Goal condition: harmony vs. conflict

A one-way ANOVA was not significant, $F(2, 430) = 2.20$, $p = .112$, $\eta^2 = 0.01$, but preregistered post hoc comparisons showed that participants in the Harmony condition reported significantly higher life satisfaction compared to those in the Conflict-Friendship condition, $b = 0.37$, $t(430) = 2.05$, $p = .041$. However, this contrast became marginal when

controlling for covariates, $b = 0.27$, $t(406) = 1.66$, $p = .097$. No effects of condition were observed on other key outcomes (emotional state, satisfaction with friends, satisfaction with health, loneliness, or network size preference), with or without controls.

5.2.2. Goal condition by germ aversion

Next, we examined the moderating role of germ aversion on the effect of goal condition on the outcomes. We found no significant interaction between goal condition and germ aversion in predicting overall life satisfaction or health satisfaction. However, when regressing friendship satisfaction on goal condition and (centered) germ aversion, a significant interaction emerged, $F(2, 427) = 4.50$, $p = .012$, $\eta^2 = 0.02$ (see Fig. 3).

When participants focused on either type of goal conflict, germ aversion was not associated with friendship satisfaction; Conflict-Health condition, $p = .162$, Conflict-Friendship condition, $p = .225$. However, when harmony between health and friendship goals was emphasized, germ aversion positively predicted friendship satisfaction, $b = 0.29$, $t(427) = 2.36$, $p = .019$.

We also analyzed the same interaction from another perspective—whether the effect of goal condition on friendship satisfaction differed depending on levels of germ aversion (see Supplement for details). Results indicated that for individuals high in germ aversion (+1 *SD*), satisfaction with friendships was greater in the Harmony condition compared to Conflict-Health or Conflict-Friendship conditions, (respectively) $b = -0.47$, $t(427) = -2.65$, $p = .008$ and $b = -0.45$, $t(427) = -2.52$, $p = .012$. In contrast, individuals lower in germ aversion (−1 *SD*) did not show clear differences in friendship satisfaction across these conditions. This suggests that for highly germ-averse individuals, who prioritize health more than their less germ-averse counterparts, emphasizing goal harmony may reduce sensitivity to perceived friendship-related costs, thereby enhancing their satisfaction with friendships.

5.3. Discussion

Study 3 indicated that, though goal harmony and conflict framing did not significantly impact global life satisfaction, a nuanced effect emerged when considering germ aversion, particularly in the well-being domain of friendship satisfaction. Harmony led individuals higher in germ aversion to report relatively greater friendship satisfaction. This association was not observed in either goal conflict condition. Highlighting goal harmony may have provided a means (friendship) to assuage germ-averse individuals' greater health-related anxiety, as friends can provide reassurance or practical help with health concerns, benefits presumably less prized by those lower in germ aversion.

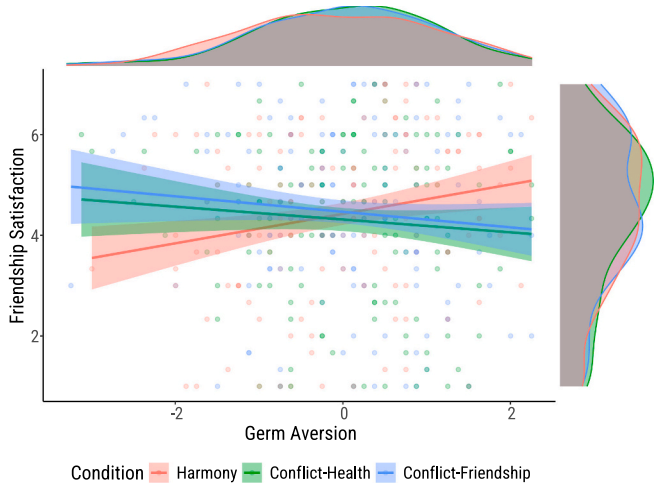

Fig. 3. Friendship satisfaction by condition and germ aversion.
Note. In the Harmony condition, participants wrote about the connection between health and friendship goals. In the Conflict-Health condition, they described how health goals interfere with friendship goals. Conversely, in the Conflict-Friendship condition, they described how friendship goals interfere with health goals.

Together, these results indicate that the perceived relationship between health and friendship goals is malleable, shifting depending on how goals are framed. This underscores the utility of harmonizing health and friendship goals to maintain social satisfaction, particularly for individuals with high germ aversion.

6. General discussion

Though friendships are generally regarded as positive influences on physical and mental health, they also introduce risks associated with contagious diseases. The spread of pathogens through social contact implies that individuals who are more sociable and interact with larger numbers of people are more likely to risk infectious disease transmission (Murray & Schaller, 2016; Nettle, 2005). As individuals vary in their sensitivity to disease cues and in how they balance relevant trade-offs (e.g., the benefits of having more friends versus the increased risk of pathogen exposure), we investigated how chronic individual differences in concerns about infectious disease are related to the size and structure of friendship networks. Across four primary studies (and three supplemental studies), we consistently found that disease-sensitive individuals tended to have smaller friendship networks compared to those less sensitive to disease threat, particularly in their outer friendship circles.

Studies 1a (conducted in the United States) and 1b (conducted across six countries) revealed a negative association between germ aversion and the number of friends people possessed across layers of friendship varying in closeness and frequency of contact, from best friends to acquaintances. This suggests that highly germ-averse individuals prioritize disease avoidance over expanding their social networks. Because these individuals may be especially attuned to the potential health costs of social affiliation, limiting their networks could serve to reduce the perceived risk of germ exposure.

Study 2 replicated this finding and further indicated that germ-averse (and disgust sensitive) individuals both want (ideal) and believe they need smaller (ought) networks. This distinction was most pronounced in outer network layers, consistent with the possibility that closer friends provide greater relationship benefits. Interestingly, although germ-averse people had more fixed and higher standards for their friends, particularly with respect to agency, similarity, and instrumental support, their standards were apparently not often met. They reported receiving less tangible support from friends than did people low in germ aversion. This ironic effect may stem from simply having too few friends to provide adequate support—these participants consistently reported needing more friends than they actually had (despite those oughts/ideals being relatively low compared to less germ averse participants). Interestingly, perceived friend inadequacy was present across levels of germ aversion, suggesting that other factors may contribute as well (e.g., the broader "loneliness epidemic"; Surkalim et al., 2022).

Finally, Study 3 explored the psychological implications of this dynamic. Framing health and friendship goals as complementary rather than in conflict led highly germ-averse individuals, more so than those with lower germ aversion, to report higher friendship satisfaction. These findings are especially relevant given the friend discrepancy finding from Study 2. The malleability of health and friendship goals may provide a useful leverage point to help bridge that divide and perhaps mitigate negative consequences associated with perception of inadequate social support (Rodriguez, Schertz, & Kross, 2025).

6.1. Theoretical contributions

Friends, when chosen wisely, provide substantial benefits, including

instrumental support (DeScioli & Kurzban, 2009; Tooby & Cosmides, 1996), emotional support (Demir & Weitekamp, 2007; Sun, Harris, & Vazire, 2020), promotion of physical well-being (Ho, 2014; Holt-Lunstad et al., 2010; Steptoe, Shankar, Demakakos, & Wardle, 2013), increased life satisfaction (Dunbar, 2018; van der Horst & Coffé, 2012), and even harm to one's enemies (Krems et al., 2023). Research has explored how friendships balance and reciprocate such benefits, but less attention has been paid to the potential costs of friendships, particularly regarding physical health. While studies often emphasize the protective health effects of friendships, such as reduced risks for non-infectious diseases like cardiovascular conditions and disorders involving neuroendocrine and inflammatory processes (e.g., Hawkley & Capitanio, 2015; Thoits, 2011), maintaining friendships can also increase exposure to germs and non-zoonotic infectious diseases. Our findings highlight a specific individual difference, germ aversion, that is associated with perceived costs of friendships. Perhaps because of its association with disgust sensitivity, highly germ-averse individuals appear to perceive these health costs more acutely, leading to smaller social networks and a prioritization of disease avoidance over social affiliation as well as stricter standards for the friendships they do develop. Although friendships are not solely chosen based on utility, identifying the influence of factors like germ aversion can inform our understanding of the structure and function of social networks. Preferences for the size and quality of these networks may stem from individual needs (e.g., minimizing exposure to germs), specific traits sought in friends (e.g., providing instrumental support), or the interplay between the two, where certain traits align more closely with personal priorities.

The present work also helps bridge the behavioral immune system and friendship literatures. Interpersonal and intergroup research involving the behavioral immune system has historically focused on how infectious disease concerns promote avoidance of outgroups and strangers (e.g., Ackerman, Tybur, & Mortensen, 2018; Murray & Schaller, 2016; Oaten, Stevenson, & Case, 2011), with less attention given to existing networks. Setting the stage for how such networks might function, studies have pointed to the tradeoff between affiliation and disease avoidance motives, and suggested that an initial motivation to avoid disease may result in lower motivation for social affiliation (and vice versa; Brown et al., 2019; Okruszek, Aniszewska-Stańczuk, Piejka, Wiśniewska, & Żurek, 2020; Sacco et al., 2014). Beyond encounters with strangers, recent work suggests that germ concerns may be relaxed within existing social relationships, leading to infection-risky behaviors with valued social partners (Tybur et al., 2020) and reduced disease-related vigilance when feeling securely connected to close others (Murray et al., 2023). Our findings uniquely demonstrate that germ-averse individuals do not uniformly relax their vigilance in close relationships, but instead strategically structure these relationships to align with their health-related motives.

6.2. Limitations and future directions

Our investigation of friendship networks followed from dimensions commonly explored in social network research regarding descriptive factors of friendship (i.e., how many, who are they). These of course do not encompass all aspects of friendship networks. Examination of the structural nature of friendships (e.g., density, centrality, clustering) or objective measures of interaction (e.g., actual frequency and context of contact) could provide a more comprehensive understanding of social connections (Clifton & Webster, 2017). For instance, germ aversion may exert a stronger influence on friendships that involve frequent in-person meetings, where physical proximity amplifies perceived infection risk, compared to friendships maintained primarily online or via phone, which provide social support without direct physical contact. Employing social network analysis to investigate the structural organization of these ties, or using daily diary methods to capture real-time interactions, could yield a more dynamic and objective understanding of friendship networks.

In our cross-national investigation (Study 1b), though we did not observe significant moderation by country, nuances across countries emerged. Specifically, associations were stronger in the United States (Study 1a), Germany, Brazil, and Ghana, and weaker in other countries. This variability could result from socioecological conditions (including historical pathogen prevalence; see Murray & Schaller, 2010) or culturally derived norms and tendencies shaped by these conditions (e.g., Ackerman et al., 2025). Given the substantial variability in pathogen prevalence globally and its potential influence on culture and norms surrounding friendship (Fincher, Thornhill, Murray, & Schaller, 2008; Schaller & Murray, 2008; Thornhill, Fincher, Murray, & Schaller, 2010), a wider range of countries would be valuable for more thoroughly investigating these complex relationships.

Another issue concerns the boundary conditions of our findings. We defined friendship here as a voluntary, long-term relationship that excludes family members and romantic partners. However, the term "friend" can be used to describe a wide range of ties (e.g., a colleague who is also regarded as a friend; Fehr, 1996; Kitts & Leal, 2021), and the traits people prioritize in these relationships (e.g., cooperation, status enhancement, emotional support) may differ accordingly (Eisenbruch & Roney, 2020; Williams et al., 2022). These considerations raise the question of whether the patterns we observed extend beyond friendships. Our preliminary evidence suggests that the effect of germ aversion is specific to friendships, at least compared to certain other relationship types ($N = 506$; see Study S2 in the Supplement). Replicating the main studies, individuals higher in germ aversion reported having fewer friends overall compared to those lower in germ aversion, particularly in their outer circles. In contrast, germ aversion did not predict the number of family members, coworkers, or romantic partners. Taken together, these patterns suggest that germ aversion may be most relevant for the more flexible and voluntary layers of one's social network. It appears to play little role in relationships that are structurally given (e.g., family, coworkers) or in close relationships where the benefits strongly outweigh potential costs (e.g., romantic partners, best friends).

Finally, future research might explore ways to mitigate the conflict between disease avoidance and social affiliation. In the U.S., though people express a desire for more and better-quality friendships in general (as shown in Study 2), time spent with friends has been decreasing, and less than half of people report feeling satisfied with their social interactions (Pennington, Hall, & Holmstrom, 2024; U.S. Bureau of Labor Statistics, 2025). This trend was exacerbated by the COVID-19 pandemic, which heightened the perceived conflict between disease avoidance and social affiliation, potentially leading to lasting impacts on social networks. Our findings in Study 3 suggest that goal framing might be one means of encouraging people to reevaluate prioritization of relevant goals. The perceived conflict between disease avoidance and social goals is malleable, and by viewing these goals as complementary, individuals may find greater satisfaction in their friendships. As society navigates post-pandemic challenges, such interventions could help foster resilient and fulfilling social networks.

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CRediT authorship contribution statement

Soyeon Choi: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Joshua M. Ackerman:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

We have no known conflict of interest to disclose.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.evolhumbehav.2025.106819.

Data availability

Materials, data, code, and preregistrations are available on the Open Science Framework [https://doi.org/10.17605/OSF.IO/RN6B4].

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