Title: Network meta-analysis of interventions to prevent person-to-person transmission of SARS-CoV-2 and COVID-19

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Abstract:

The evidence on relative ranking of effectiveness measures to prevent the SARS-CoV-2 spread from person-to-person is crucial for policy decision making. We have conducted the network meta-analysis by extending recent meta-analysis to delineate the relative effectiveness different preventive measures. We observed properly used N95 respirator provides the best protection against SARS-CoV-2 in overall as healthcare set-up. In community settings, social distancing offers the best risk reduction against SARS-CoV-2.

Short report

Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) causes COVID-19 and is spread person-to-person through close contact (1). A recent systematic review and meta-analysis reported lower risk of SARS-CoV-2 person-to-person transmission with that of physical distancing, face masks (N95 respirator, surgical masks) and eye protection when compared to no such interventions (2). While such pair-wise comparisons are useful, the relative ranking among these active interventions could potentially add value to such measure of prevention effectiveness. Therefore, we performed a network meta-analysis (NMA) and ranked those interventions considering combined direct and indirect comparison effects.

Methods:

We have included all the 44 relevant comparative studies in health-care and non-health-care settings (n=25,697 patients) identified in the systematic review and meta-analysis by (2) for conducting NMA. A mixed regression model was used for NMA to indirectly compare relative effectiveness of physical distance, face masks, and eye protection on virus transmission in health-care and non-health-care (eg, community) settings. We have performed the stratified NMA among healthcare workers with respect to the type of face masks used (N95 respirators or surgical face-mask). Further, we have examined the effectiveness of these measures (face mask, social distancing and eye protection) in the community setting.

The results of pooled risk ratios were provided in the form of league tables, showing the respective comparisons. Also, for the relative rankings were reported as Surface under the cumulative ranking curve (SUCRA) graph for each of the stratified NMAs.

Results:

On examining the network with all the study results, there was a disconnected map due to use of with or without N95 respirator as facemask (Figure 1).

Figure 1: The network map showing disconnection in the map indicating stratified analysis based on use of N95.

On NMA, among the studies (irrespective of healthcare or general population) that used N95 respirators, face masks provided the best protection against SARS-CoV-2 followed by eye protection and social distancing (Table 1, Figure 2).

Figure 2: Surface under the cumulative ranking curve (SUCRA) graph: NMA ranks of intervention classes to prevent SARS-CoV-2 infection with use of N95 respirator as facemask

Table 1: League table showing the results of the network meta-analysis comparing the different interventions with relative risk (95% CI); with the use of N95 use as facemask.

Eye protection	1.53 (0.58,3.98)	2.41 (0.98,5.94)	2.90 (1.15,7.27)	2.85 (1.20,6.74)	0.64 (0.24,1.72)
0.66 (0.25,1.71)	Social distance	1.58 (0.85,2.93)	1.90 (0.93,3.87)	1.87 (0.85,4.09)	0.42 (0.19,0.94)
0.41 (0.17,1.02)	0.63 (0.34,1.17)	Control Social distance	1.20 (0.65,2.23)	1.18 (0.59,2.38)	0.26 (0.13,0.54)
0.35 (0.14,0.87)	0.53 (0.26,1.07)	0.83 (0.45,1.54)	Control Face mask	0.98 (0.49,1.99)	0.22 (0.12,0.39)
0.35 (0.15,0.83)	0.54 (0.24,1.17)	0.85 (0.42,1.71)	1.02 (0.50,2.06)	Control Eye protection	0.22 (0.10,0.49)
1.57 (0.58,4.25)	2.40 (1.07,5.39)	3.79 (1.87,7.70)	4.55 (2.54,8.16)	4.48 (2.05,9.77)	N95 Respirator

On NMA, among the studies (irrespective of healthcare or general population) that used surgical face mask, eye protection offered the maximum protection followed by social distancing and surgical face mask (Table 2, Figure 3).

Table 2: League table showing the results of the network meta-analysis comparing the different interventions with relative risk (95% CI); without the use of N95 respirator as facemask

Eye protection	0.96 (0.48,1.92)	3.36 (1.72,6.56)	4.31 (2.22,8.37)	2.45 (1.22,4.93)	1.71 (0.87,3.37)
1.04 (0.52,2.09)	Social distance	3.51 (2.32,5.29)	4.50 (2.78,7.29)	2.56 (1.40,4.68)	1.78 (1.06,2.99)
0.30 (0.15,0.58)	0.29 (0.19,0.43)	Control Social distance	1.28 (0.84,1.97)	0.73 (0.41,1.30)	0.51 (0.32,0.81)
0.23 (0.12,0.45)	0.22 (0.14,0.36)	0.78 (0.51,1.19)	Control Face mask	0.57 (0.32,1.01)	0.40 (0.26,0.61)
0.41 (0.20,0.82)	0.39 (0.21,0.71)	1.37 (0.77,2.44)	1.76 (0.99,3.14)	Control Eye protection	0.70 (0.38,1.27)
0.59 (0.30,1.15)	0.56 (0.33,0.94)	1.96 (1.23,3.14)	2.52 (1.63,3.91)	1.43 (0.79,2.61)	Surgical face mask

Figure 3: SUCRA graph: NMA ranks of intervention classes to prevent SARS-CoV-2 infection without use of N95 respirator as facemask

On stratified NMA, among health care persons with N95 respirators provided the best protection against SARS-CoV-2 followed by eye protection and social distancing (Table 3, Figure 4).

Table 3: Among healthcare persons: League table showing the results of network meta-analysis comparing the different interventions with relative risk (95% CI); with the use of N95 use as facemask.

Eye protection	1.50 (0.57,3.94)	2.43 (0.98,5.98)	2.90 (1.15,7.28)	2.84 (1.20,6.75)	0.63 (0.23,1.72)
0.66 (0.25,1.74)	Social distance	1.61 (0.86,3.02)	1.92 (0.94,3.95)	1.89 (0.86,4.16)	0.42 (0.19,0.95)
0.41 (0.17,1.02)	0.62 (0.33,1.16)	Control Social distance	1.19 (0.64,2.22)	1.17 (0.58,2.37)	0.26 (0.13,0.53)
0.35 (0.14,0.87)	0.52 (0.25,1.07)	0.84 (0.45,1.56)	Control Face mask	0.98 (0.48,1.99)	0.22 (0.12,0.39)
0.35 (0.15,0.83)	0.53 (0.24,1.16)	0.85 (0.42,1.72)	1.02 (0.50,2.07)	Control Eye protection	0.22 (0.10,0.49)
1.58 (0.58,4.27)	2.37 (1.05,5.35)	3.82 (1.88,7.79)	4.56 (2.54,8.19)	4.48 (2.05,9.80)	N95 Respirator

Figure 4: SUCRA graph among healthcare persons: NMA ranks of intervention classes to prevent SARS-CoV-2 infection with use of N95 respirator as facemask

On stratified NMA, among health care persons without respirators (but use of facemasks) as compared to controls, eye protection offered the best risk reduction followed by social distancing and surgical face mask (Table 4, Figure 5).

Table 4: Among healthcare persons: League table showing the results of the network meta-analysis comparing the different interventions with relative risk (95% CI); without the use N95 respirator as facemask

Eye protection	1.25 (0.67,2.35)	2.55 (1.43,4.56)	3.97 (2.20,7.18)	2.45 (1.38,4.34)	1.42 (0.78,2.57)
0.80 (0.42,1.50)	Social distance	2.04 (1.23,3.37)	3.17 (1.84,5.44)	1.95 (1.14,3.36)	1.13 (0.65,1.97)
0.39 (0.22,0.70)	0.49 (0.30,0.81)	Control Social distance	1.56 (1.03,2.34)	0.96 (0.59,1.56)	0.56 (0.36,0.86)
0.25 (0.14,0.46)	0.32 (0.18,0.54)	0.64 (0.43,0.97)	Control Face mask	0.62 (0.37,1.02)	0.36 (0.24,0.54)
0.41 (0.23,0.72)	0.51 (0.30,0.88)	1.04 (0.64,1.69)	1.62 (0.98,2.68)	Control Eye protection	0.58 (0.35,0.97)
0.70 (0.39,1.28)	0.88 (0.51,1.54)	1.80 (1.16,2.80)	2.80 (1.84,4.25)	1.73 (1.04,2.88)	Face mask

Figure 5: SUCRA graph among healthcare persons: NMA ranks of intervention classes to prevent SARS-CoV-2 infection without use of N95 respirator as facemask

In the community settings and with the use of surgical mask, social distancing offered the best protection followed by surgical mask (Table 5, Figure 6). However, the studies examining the combination of these measures were limited

Table 5: Among Non-Healthcare persons: League table showing the results of the network meta-analysis comparing the different interventions reporting relative risk (95% CI); without the use N95 respirator as facemask

Face mask	0.30 (0.10,0.95)	1.63 (0.53,5.06)	1.51 (0.55,4.14)
3.30 (1.05,10.33)	Social distance	5.40 (2.85,10.22)	4.97 (1.81,13.67)
0.61 (0.20,1.89)	0.19 (0.10,0.35)	Control Social distance	0.92 (0.34,2.50)
0.66 (0.24,1.83)	0.20 (0.07,0.55)	1.09 (0.40,2.95)	Control Face mask

Figure 6: SUCRA graph among non-healthcare persons: NMA ranks of intervention classes to prevent SARS-CoV-2 infection without use of N95 respirator as facemask

Conclusion:

In conclusion, among all population as well as specific health care persons, properly used N95 respirator provides the best protection against SARS-CoV-2. In community settings, social distancing offers the best risk reduction against SARS-CoV-2. However future studies could direct in assessing combined use of face-masks as well as social distancing.

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