**Appendix 6. Association of variables facial dimensions, gender and ethnicity with RPE fit**

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| ***Studies*** |  | ***Pass rates (PR)***  ***Users/RPE groups\**** |  | ***Association between facial dimensions (FD) and fit\*\**** |  | ***Association between gender and fit\*\**** |  | ***Association between ethnicity and fit\*\**** |  | ***Association of mask factors\*\*\**** | ***Recommendations or conclusions made by authors*** |
| **Liau et al.  (1982) 48**  **US** |  | N/A |  | low correlation coefficients but greatest for FW and LW |  | N/A |  | N/A |  | N/A | No FD recommendation |
| **Gross and Horstman**  **(1990) 49**  **US** |  | Users: 95% ♂: 83-85% ♀: 71-89% (RPE dependent) |  | Nose and lip measurements were relevant but no significant correlation |  | PR for 2/3 RPE models: ♂ > ♀  Comparable PR between genders with >1 RPE models |  | N/A |  | variability of FF based on brand for ♀ | No FD recommendation. Need to offer variety in RPE model and size. |
| **Oestenstad et al. (1990) 50**  **US** |  | N/A |  | High prevalence of nose leaks. Significant correlation for NRB, BIOC, LFL to FF. |  | Association of facial dimension and leak sites attributed to gender. Greater predictability with gender specific models. |  | N/A |  | N/A | Consideration for inclusion of nasal dimensions |
| **Oestenstad and Perkins**  **(1992) 27**  **US** |  | Users: 80.9% |  | FDs predict fit.  LFL alone is a good predictor. FL and NRB are also relevant |  | Gender based differences in fit predicted by differences in FD.  Greater predictability with race/gender specific models |  | Race specific models improve predictive ability |  | N/A | Other FDs (i.e. LFL) may be more appropriate |
| **Brazile et al.  (1998) 51**  **US** |  | Users: 91.9% ♂: 91.2% ♀: 92.6% |  | NW and NP were associated with FF but account for small percentage of FF variation and were not good predictors of fit |  | No significant association  Comparable FF and PR between genders |  | Black♀:  lowest PR  No effect on FF |  | N/A | Fit is associated with individual FD rather than FD associated with gender or ethnicity |
| **Han (2000) 52**  **South Korea** |  | RPE groups:  30.9 - 77.2% |  | Significant FF variation between facial size categories |  | Difference in FF scores: ♂ > ♀ |  | Low/moderate PR amongst Korean users ‡ |  | Significant difference in FF and PR between brands | Respirators designed for males may not fit females. FL and LW alone are not good criteria |
| **Han and Choi (2003) 29**  **South Korea** |  | ♂: 58 - 78.6% ♀: 34.2 - 50%  (RPE dependent) |  | FW, NP and BTMA arc are good predictors of fit. No common FD variable across all RPE/gender subgroups |  | Difference in PR for 2/3 RPE models: ♂ > ♀ Gender-specific models  account for most variation in fit factor |  | Low/moderate PR amongst Korean users ‡ |  | Significance difference in FF and PR between brands | The 3 FD predictive of fit should be considered in designing RPE for Koreans |
| **Kim et al.**  **(2003) 53**  **South Korea** |  | ♂: 41.4 - 87% ♀: 10.3 - 60%  (RPE dependent) |  | ♂: No correlation for FD and FF  ♀:5 FD correlate with FF (BTSA, BECTO, BTMA, JW, LFL)  FW, LFL, BIOC, BECTO, NL, LW, BTSA predict PR/fit (gender/RPE dependent) |  | Difference in FF and PR: ♂ > ♀  Greater predictability with gender specific models |  | Low/moderate PR amongst Korean users ‡ |  | Significance difference in FF and PR between brands | Consideration of alternative FD in design of quarter mask respirators for Koreans |
| **Zhuang et al. (2005) 54**  **US** |  | N/A |  | 16/33 models of RPE model/size combinations show association of FD and FF. JW, FW, FL, NP were frequently relevant |  | Comparable FF between genders for 16/18 RPE models |  | N/A |  | FF associated with number of sizes per model. No effect of RPE design | FL and FW are recommended for defining the panel |
| **Oestenstad et al. (2007) 55**  **US** |  | N/A |  | Association between FD and FF varied among gender and RPE brands  JW, BECTO, FW, FL, LW were associated with FF |  | No gender difference in FF after controlling for FD |  | N/A |  | Significant difference between brands | Consideration of FD associated with FF than other than FL and LW for RPE design and test groups |
| **McMahon et al. (2008) 56 Canada** |  | ♂: 85.4% ♀: 95.1%  (first choice RPE)  6 ♀failed all RPE |  | N/A |  | Difference in PR: ♂ > ♀ |  | N/A |  | N/A | Females require a wider variety of respirator choices |
| **Zhuang et al.**  **(2008) 57**  **US** |  | RPE groups:  0 - 96%  (panel dependent) |  | Association of FD with FF and PR depends on RPE size. Highest FF and PR with matched facial size category and RPE size |  | N/A |  | N/A |  | RPE size significantly influences FF and PR within a given facial size category | FL and FW are appropriate for developing bivariate RFTP |
| **Winter et al.**  **(2010) 58**  **Australia** |  | Users: 72%  RPE groups:  16 - 34% |  | HC not predicative of successful fit testing and comparable between passing and failing groups |  | Gender not predictive of successful fit testing |  | N/A |  | N/A | A variety of masks (at least five types) should  be made available to HCWs |
| **Wilkinson et al. (2010) 59**  **Australia** |  | Users: 89% |  | Lower PR associated with extremes of NL and NRB and round face shape but small absolute differences.  NRB was predictive of fit but with small effect size. |  | Comparable PR between genders |  | White: highest PR  Asians: lowest PR |  | Brand differences based on face shape | Facial characteristics are important determinant of a successful RPE fit test |
| **Oestenstad and Bartolucci**  **(2010) 60**  **US** |  | N/A |  | FD were significant different between groups with and without inward leakage |  | no gender effect on location and shape of leaks |  | N/A |  | N/A | Size and shape of an individual’s face may be an important determinant of leak sites |
| **Spies et al.  (2011) 61**  **South Africa** |  | Users: 13.8% |  | Narrower FD amongst those who passed |  | Comparable FF between genders |  | Non-significant ethnicity-based variation in FF  Low PR amongst South African users ‡ |  | N/A | More than one  type and size respirator should be included |
| **Ciotti et al.**  **(2012) 30**  **France** |  | Users: 63%  All fit tests: 26.8%  3.3 - 57.5%  (RPE dependent) |  | N/A |  | N/A |  | Low PR amongst French users ‡ |  | Significant difference in FF and PR between models | At least two types of RPE with various sizes and shape should be available for HCWs |
| **Earle-Richardson et al. (2014) 62**  **US** |  | Users: 75% |  | N/A |  | N/A |  | RPE fitting American users are a good fit for only 41% of Latino farmworkers |  | N/A | A wide range of mask types should be made available for Latino farmworkers |
| **Yu et al. (2014) 63**  **China** |  | Users: 46% RPE groups:  0-44.7% |  | Highest FF associated with medial FL and FW.  Lower FF associated with extremes of FD: longer FL and narrower FW. |  | Difference based on RPE †  Model D1 FF: ♂ > ♀  Model D2 FF and PR: ♀ > ♂ |  | Low PR amongst Chinese users ‡ |  | Significant difference between models | Consideration of Chinese FD in design of RPE for Chinese users |
| **Bergman et al. (2014) 64**  **US** |  | N/A |  | Association of FD with FF depends on RPE size. Good fit performance of models in their respective facial size categories |  | N/A |  | N/A |  | RPE model influences FF within facial size categories | FL and FW are appropriate for developing bivariate RFTP |
| **Kim et al.**  **(2015) 65**  **South Korea** |  | Users: 73.5% |  | N/A |  | N/A |  | N/A |  | N/A | FF has low correlation with SWPF. Different RPE sizes should be provided for HCWs |
| **Lin et al. (2017) 66**  **Taiwan** |  | RPE groups:  37.6 - 52.5% |  | Respirator fit dependent of facial size category. Fit increased with increasing FD |  | N/A |  | Low PR amongst Taiwanese users ‡ |  | Significant difference between models | Development of RFTP for smaller-medium FD |
| **Manganyi et al. (2017) 28**  **South Africa** |  | Users: 22% |  | PR associated with FD.  Overall: Face size and NRB associated with FF  ♀: FL and NRB associated with FF  FD explain small proportion of FF variability |  | Difference in FF and PR: ♂ > ♀ (only clean-shaven men††) |  | Low PR amongst South African users ‡  Asian♀: lower PR and FF. Race did not predict FF by logistic regression |  | FF and PR affected by shape and brand. RPE is a determinant of fit | NRB may be useful in RPE selection |
| **Honarbakhsh et al. (2018) 67**  **Iran** |  | Users: 10.6%  RPE group:  0 – 20% |  | no relationship between fit and facial size categories |  | Difference in FF and PR: ♂ > ♀ |  | Low PR amongst Iranian users ‡ |  | Significant difference between models | Consideration of Iranian FD in RPE design |
| **Huh et al.**  **(2018) 68**  **South Korea** |  | Users: 69.2%  RPE groups:  18.8 – 46.0% |  | Highest PR associated with larger face sizes for 1/4 RPE model |  | Difference in FF for 3/4 RPE models: ♂ > ♀  Male gender was an independent predictor of FF for 3/4 models |  | Low PR amongst Korean users ‡ |  | Significant difference between models | Consideration of Korean FD in RPE design |
| **Foereland et al. (2019) 69**  **Norway** |  | users: 96%  RPE groups:  19-100% |  | N/A |  | FF not predicted by gender |  | N/A |  | RPE model strongly predicted fit | Provision of multiple (5-6) respirators in fit test program |
| **Winski et al.  (2019) 70**  **UK** |  | Users: 94.7% |  | Weak association for FW and JW with FF.  No association of face size categories with FF.  No association of FD with PR |  | N/A |  | N/A |  | N/A | Consideration of JW in RPE design if absolute FF scores are of value |
| **Fakherpour et al. (2020) 71**  **Iran** |  | All fit tests: 15.73%  RPE group:  1.6-43.5% |  | No association of face size and PR within RPE groups |  | Difference in PR: ♀ > ♂ |  | Low PR amongst Iranian users ‡ |  | Significant difference in PR between models and shape | Consideration of Iranian FD in panels and RPE design and provision of provide various sizes and shapes of RPE |
| **Zhang et al.  (2020) 72**  **China** |  | ♂: 54.8-61.3% ♀: 31.5-64.8% (RPE dependent) |  | PR associated with FL, NL and diagonal NL.  FF correlated with FL, NL and NW correlated (RPE dependent). |  | Comparable PR between genders across all user/mask tests  Difference in PR for 1/4 RPE model: ♂ > ♀ |  | Low PR amongst Chinese users ‡ |  | Significant difference between models | Anthropometric dimension of Chinese users should be considered for RPE design |
| **De‐Yñigo‐Mojado et al.**  **(2021) 73**  **Spain** |  | ♂: 2.7-21.6% ♀: 13.5-48.4% |  | N/A |  | Difference in PR: ♀ > ♂ |  | Low PR amongst Spanish users ‡ |  | N/A | Support for appropriate fit testing HCWs |
| **Fakherpour et al. (2021) 74**  **Iran** |  | RPE groups:  0-43.2% |  | No association of face size and PR within RPE groups |  | Comparable PR between genders |  | Low PR amongst Iranian users ‡ |  | Significant difference in PR between models and shape | Provide various sizes and shapes of RPE and fit testing guided by FD |
| **Williams et al. (2021) 75**  **Australia** |  | Users: 92%  (100% using rescue mask)  RPE groups:  65 – 77% |  | N/A |  | No association of PR with gender |  | No association of PR with ethnicity (underpowered) |  | Comparable PR between models | Support for implementation of fit test programme |

Red bars indicate studies reporting low/low-moderate pass rates for respective cohorts and RPE investigated. Yellow bars indicate studies reporting mixed results for association of respective variable and RPE fit. Greens bar indicate studies reporting clear associations.

N/A = not available/assessed; ♀= female; ♂ = male; FF = fit factor; PR = pass rates; FD = facial dimensions; BECTO = Biectoorbitale breadth; FW = Face width/Bizygomatic breadth; JW = Jaw width/Bigonial breadth; FL = Face length/Menton-nasion length; LFL = Lower face length = Menton-subnasale length; NL = Nose length/Subnasale-nasion length; BIOC = Biocular breadth; NRB = Nasal root breadth; NW = Nose width; LW = Lip width; BTMA = Bitragion-menton arc; BTSA Bitragion-subnasale arc; NP = Nose protrusion; HC = head circumference.

\* PR are reported as either (1) PR of users, as a percentage of participants who passed fit-testing on at least one respirator or (2) PR for RPE groups, as a percentage of participants who passed fit-testing for the respirator being tested

\*\* RPE fit as measured by respective studies, including fit/protection factor (FF), simulated workplace protection factor (SWPF), inward leakage (IL), fit-testing pass rates (PR)

\*\*\* Mask factors are reported as any differences in FF or PR relating to mask factors such design, model, brand, shape or size

† Model D1 and D2 yielded highest pass rates (42& and 20%, respectively). Remaining 8 models yielded pass rates of 0-7.6%

†† Analysis of all men (included those with facial hair/stubble) showed comparable pass rates. Analysis of only clean-shaven men shown here as facial hair has been demonstrated in literate to worsen fit.

‡ studies reporting on RPE protection for ethnic minority groups but without within study comparison between ethnic groups