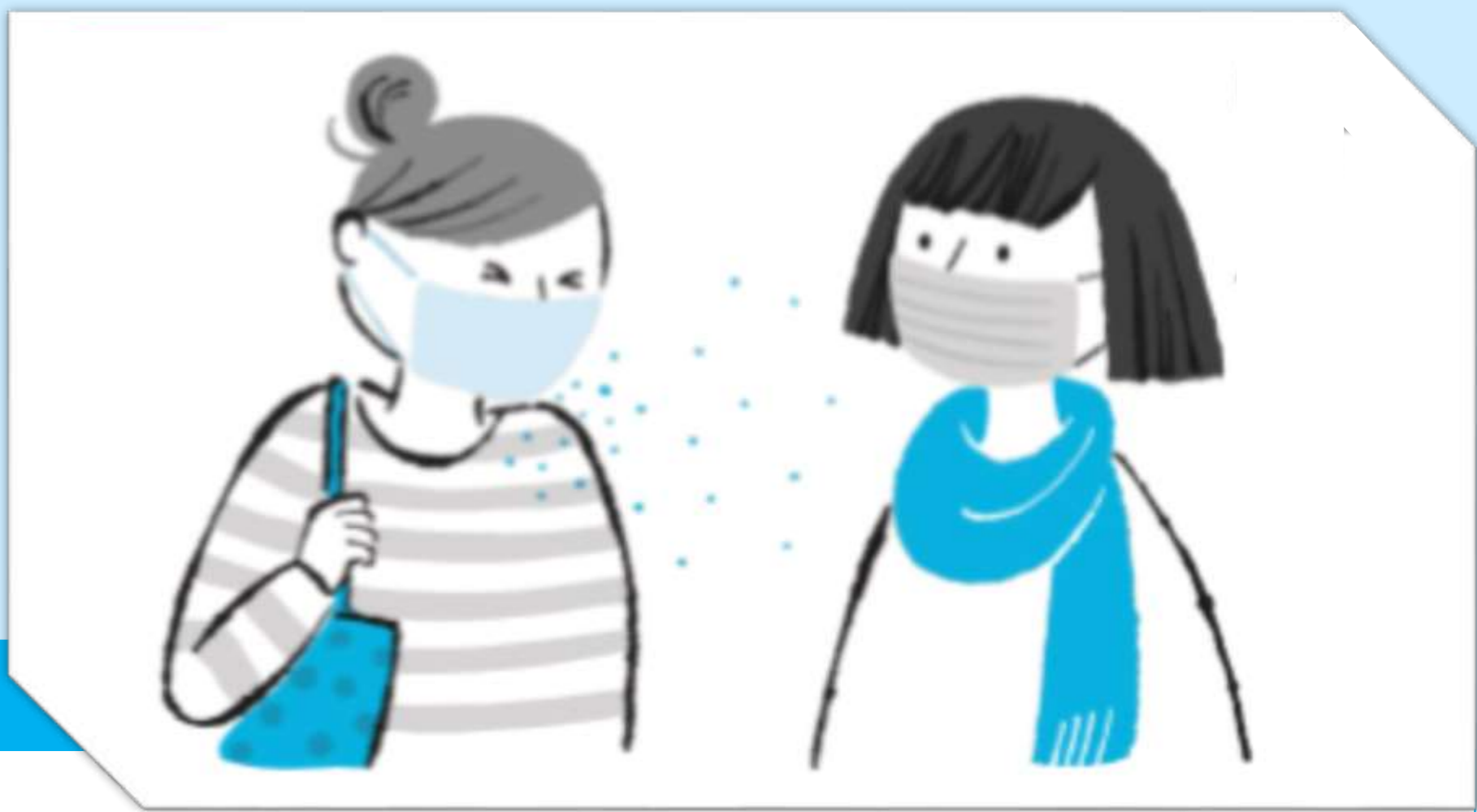


Respiratory protection effect of disposable type dust respirators and non-medical face masks using non-woven fabric

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1. Objectives

The objective of this study was to provide quantitative information for appropriate selection and use of masks to control infection, such as COVID-19. We examined the leak rates of disposable type dust respirators and non-medical face masks using human subjects before and after instructions for wearing masks.

2. Background

Due to the epidemic of COVID-19 that has been ongoing since December 2019, the evaluation of the respiratory protection effect is being required even for masks used in the general environment for infection prevention. In the research on industrial respiratory protective devices (RPDs), it is recognized that the respiratory protection effect of RPDs changes depending on the facial features of the wearer, the wearing method, and the movement when donning it. However, there are few research reports on non-medical face masks that evaluate their respiratory protection effect, including the viewpoints mentioned above.

3. Method

- Masks: Three types of disposable type dust respirators and ten types of non-medical face masks with non-woven fabric (Table 1).
- Subjects: Nine subjects (one woman, eight men), aged 22-36 years (Table 2, Fig.1).
- Fit test method: Using a Mask Fitting tester MT-05U™ (Shibata Science Co., Ltd, Japan), air sampling in the masks was performed using the push-on-ring method. The leak rate was measured while performing eight movements (breathing normally, deep breathing, turning head side to side, moving head up and down, talking, grimacing, bending over, breathing normally). Furthermore, measurements were taken before and after instruction for wearing masks. Additionally, the filtering efficiency and pressure loss of the filter were measured to confirm the mask-specific performance.

Table 1 Product name and manufacture name, appearance of 13 masks

No.	manufacture name	product name	appearance	No.	manufacture name	product name	appearance
A	KOKEN Ltd.	Hi-luck 350		H	Kowa Company Ltd.	3-Dimensional ko-michchaku Mask	
B	SHIGEMATSU WORKS Co., Ltd.	DD02-S2-2K		I	Unicharm Corporation	Cho-kaiteki Mask Pleated type	
C	3M Ltd.	Vflex™		J	IRIS OHYAMA Inc.	Rittai Mask	
D	ARAX Co., Ltd.	PITTA® MASK 2.5		K	Tamagawa-Eizai Co., Ltd.	Fitty® 7DAYS Mask EX	
E	Kowa Company Ltd.	3-Dimensional Mask		L	TOPVALU Co., Ltd.	Uirusu Himatsu, PM2.5 Taisaku Non-woven Mask	
F	Unicharm Corporation	Cho-rittai Mask colds・pollen		M	BMC Co., Ltd.	Fit Mask	
G	HAKUGEN Earth Co., Ltd.	Kaiteki ga-do pro Pleated type					

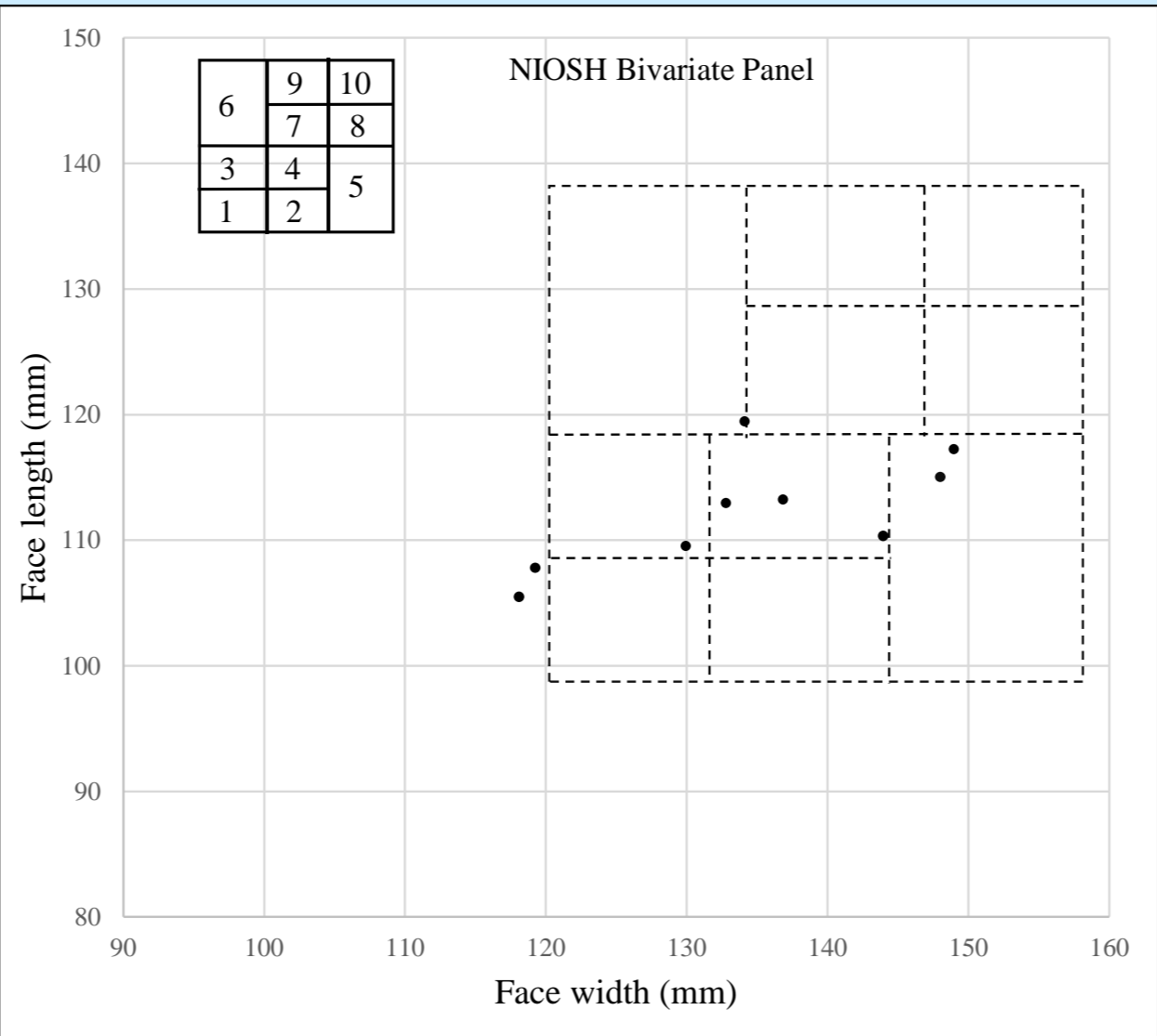


Fig.1 Face size of subjects

Table 2 The subjects' face measurement data, average, SD, minimum, maximum

Subject No.	1	2	3	4	5	6	7	8	9	Average ± SD	Min	Max
Lip width (mm)	46	53	53	39	51	49	46	49	52	48.7 ± 4.5	39	53
Nose width (mm)	39	40	36	34	39	41	35	31	36	36.8 ± 3.2	31	41
Face length (mm)	115	111	114	110	118	114	108	106	120	112.9 ± 4.6	106	120
Face width (mm)	148	144	137	131	149	133	119	118	134	134.8 ± 11.3	118	149

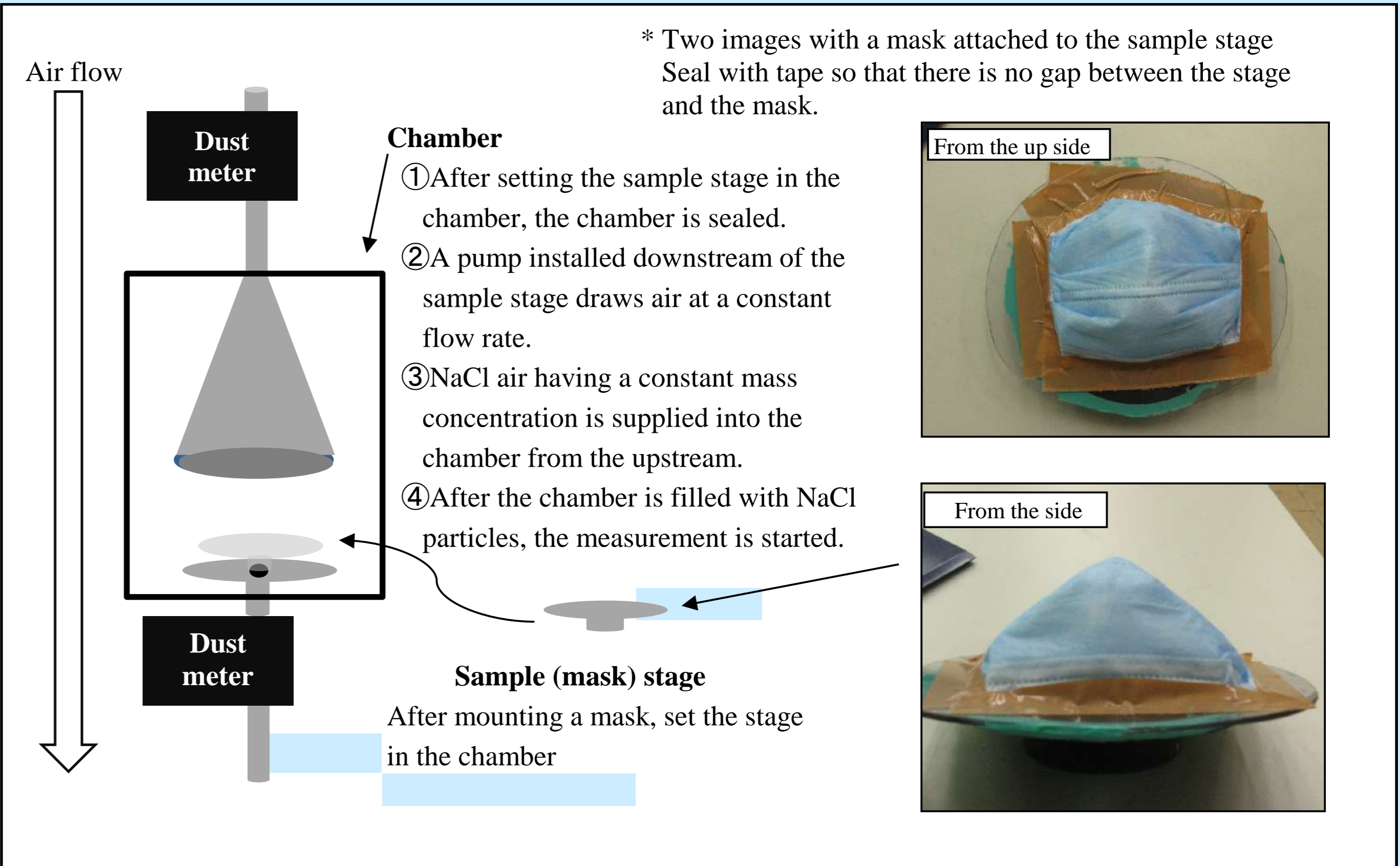


Fig.2 Measurement states of filtering efficiency of masks

4. Result

The measured leak rate of disposable type dust respirators A~C improved 3.8 to 5.9 times after instruction for wearing masks. Moreover, the respiratory protection effect of non-medical face masks D~M with non-woven fabric improved 1.1 to 1.7 times after instruction for wearing masks. It was suggested that instruction for wearing masks have a greater effect on disposable type dust respirators. The leak rate of masks A~C after instruction for wearing masks was 2.1~17.9%, and the average leak rate was 12.0%. The leak rate of masks D~M after instruction for wearing masks was 24.7~73.7%, and the average leak rate was 49.8%. Differences were found in the respiratory protection effectiveness depending on the product, even in the category of disposable type dust respirators and non-medical face masks with non-woven fabric.

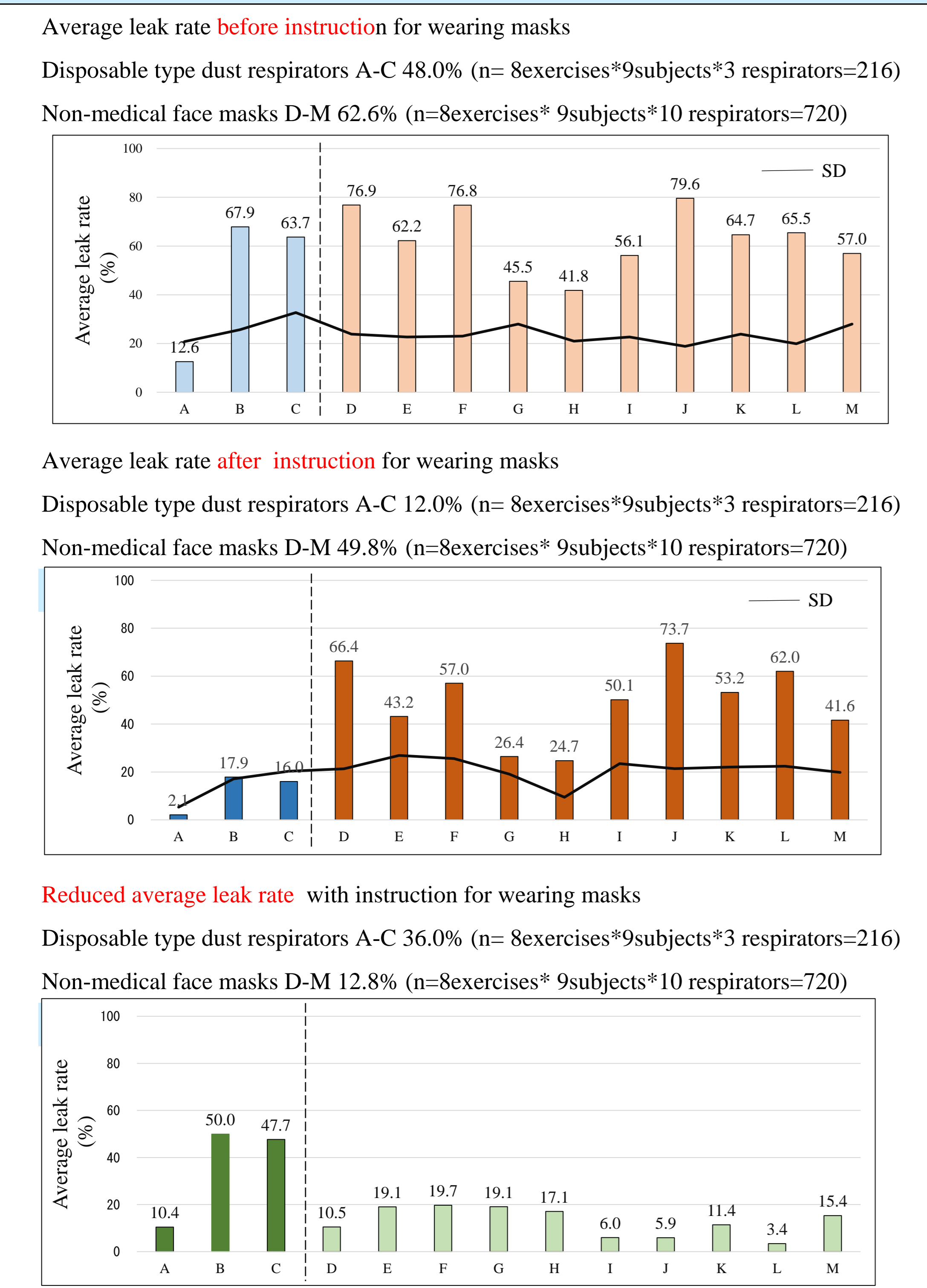


Fig.3 Leak rate before and after instruction for wearing masks and reduced leak rate with instruction for wearing masks

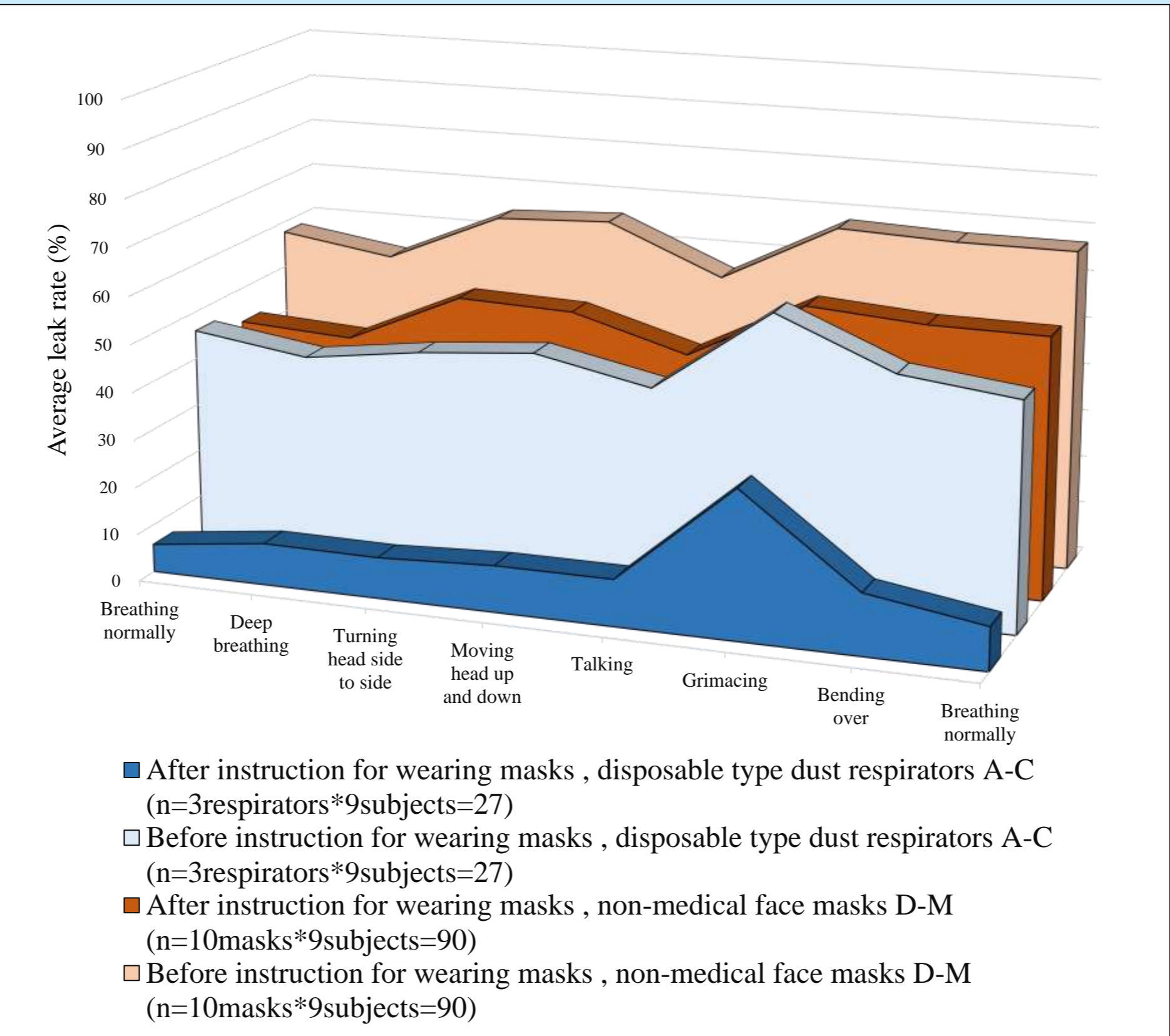


Fig.4 Effects of instructional method and exercise on leak rate

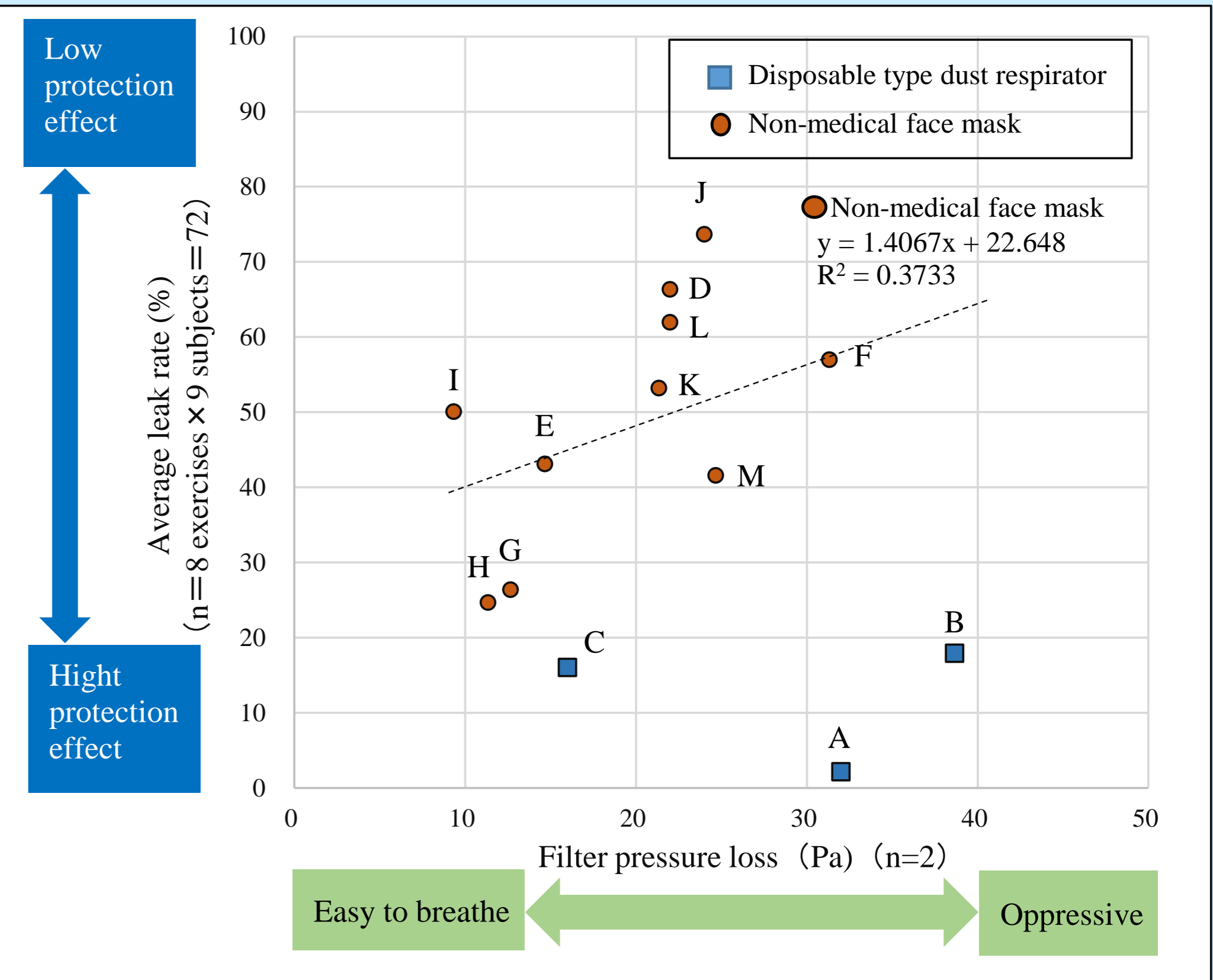


Fig. 6 The relationship between average leak rate after instruction for wearing masks and filter pressure loss (Pa)

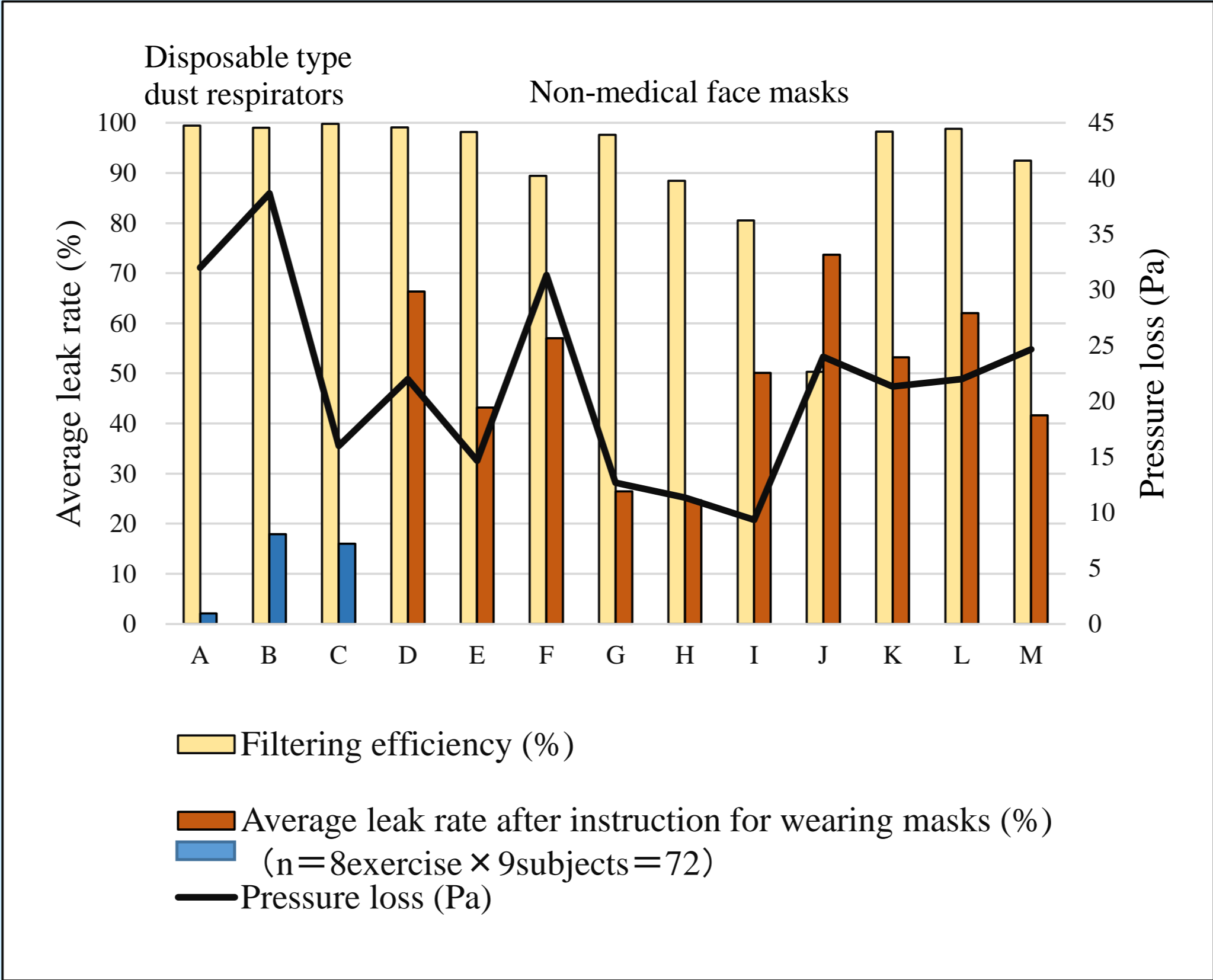


Fig.5 The relationship between filtering efficiency and protection effect