Annex II: Mask-Use Adherence Measurement Technical Reference

This guide aids in the design and implementation of a program to measure, monitor and provide feedback on mask-use adherence. The percentage of people wearing masks in public indoor locations is one of 15 essential indicators identified by Resolve to Save Lives that can be used to inform decision making. The word "mask" in this document refers to cloth face coverings, medical or surgical face masks, or N95 respirators. "Correct mask use" refers to wearing a mask in such a way that it completely covers the nose, mouth and chin, and fits snugly against the sides of the face.

1. PURPOSE

The purpose of observing mask use is to determine the proportion of the population that wears a mask and the proportion that wears a mask correctly. Through observation, data on mask use can be gathered in different locations and at different times. Depending on the methodologic approach to data collection, results may inform on mask-wearing behavior among 1) people who visit selected indoor public locations, 2) people who visit categories or groups of public indoor locations, or 3) a more general measure of the population-at-large. Results can be used to inform the public about mask use in their communities and to facilitate public health decision making, including identification of strategies to promote correct mask use. Results can also be used to assess the impact of interventions designed to improve rates of correct mask use.

2. DATA COLLECTION MODALITIES

Several modalities may be used to measure mask use. In-person observation is the focus of this guide because it is the best way to collect accurate, objective, timely measurements with fewer privacy concerns. In-person observation has been used successfully to measure adherence to infection prevention and control activities such as hand hygiene and the correct use of personal protective equipment, and to guide feedback and interventions for improving adherence. Alternatively, mask use can be directly observed by reviewing live or recorded video footage or indirectly assessed by asking people about their behavior in self-report surveys.

Observation

- In-person observation is an optimal method of data collection. The data collection methodologies discussed below are most relevant to in-person observation. In order to avoid duplication of measurements within an observation session, observation is typically conducted in one of two fashions: a stationary observer measures adherence by passersby, or a mobile observer measures adherence in stationary people. Within an observation session, each observer will use an observation form to document observed data. In general, most observations will be made by a stationary observer at an entry or exit point of a designated location.
- Live or recorded video offers an alternative observation modality. Non-audio video, such as footage from security cameras at store entrances, may be reviewed in live or recorded

format by human observers. Video may be useful if high- or low-volume observation points make it difficult to collect data accurately in real time or if the presence of an observer may affect mask-wearing behavior (the Hawthorne effect). Although in-person observation and observation of video footage share a number of methodologic elements, observers who will review video footage would require training on how to capture data from video images. A number of technology platforms that offer automated assessment of mask adherence from video footage have been developed. None of these platforms can be endorsed to accurately assess mask usage patterns at this time, in part because of a lack of performance data and in part due to privacy and legal concerns. If validated and legally cleared, automated assessments might provide useful, aggregated data on mask-wearing in the future.

Surveys

A second modality for gathering data is to do so indirectly by administering surveys in which people self-report mask use. Advantages of surveys include: 1) opportunity to collect some of the optional data (mask type, demographic information such as age, gender, race/ethnicity) mentioned below; 2) many jurisdictions already collect representative public health information through telephone, in-person or online questionnaires; questions about masking behavior could be incorporated into these preexisting instruments; and 3) information about beliefs and attitudes towards mask use may be collected and these data can inform targeted interventions to improve mask-use adherence. If done with a statistically sound methodology and rigor, surveys may add valuable granular information to observation data.

An important drawback to the use of surveys is that collected data may be inaccurate due to reporting biases. If using surveys, it is ideal to collect observed data concurrently, so that data may be compared and validated (for example, by collecting survey data using questionnaires administered in the same locations where observations are being made, if sufficient resources are available).

3. TRAINING OBSERVERS

Training observers on how to measure mask use can produce uniform observations that reflect reality as closely as possible and as consistently as possible between observers and over time. Training can be done remotely using a computer-based training module or written material. Consider using pre-recorded video as part of training observers, and to facilitate the opportunity to ask questions about mask-use measurements. A simple assessment can be used to ensure that the training has been effective. Training should include:

- Purpose and goals of measuring mask-use adherence
- How measurements will be used
- Data confidentiality
- Observation methodology
- Rules of observation
- Definition of a mask
- Correct mask use

- Forms to be used for measurement and how to report them
- Observer safety and security

4. RULES OF OBSERVATION

Only trained observers should perform measurements. To the extent possible, observers should not engage with those being observed. Observers should be provided with a prepared statement, on behalf of their public health department or organization, to explain what they are doing. Given potential security concerns and the politicization of mask use in certain communities, observers should make every effort to remain covert. Bias introduced through the Hawthorne effect (wherein people change their behavior because of the knowledge that they are being observed) can be minimized if observation is conducted discreetly.

- Observers should model correct mask use at all times.
- Observers should use their anonymized assigned ID for data collection.
- Neither the identities of those being observed nor personal identifiers should be collected.
- Collected data should be kept confidential with respect to location, date and time.
- The role of the observer is to objectively collect information on mask use.
- Observers should be positioned in locations where they are able to clearly observe mask use.
- Observers should only record exactly what they are able to see. For example, if an observer misses an opportunity to observe a person's face but notices mask straps behind their head or ears, it should not be assumed that the mask was being worn correctly (i.e. covering both the nose and mouth).
- Observers should not engage with those being observed. If the observer is approached and questioned by someone, the observer should be ready with a prepared statement to explain what they are doing. Ideally, the statement will be sufficient to end the interaction there.
- If an observer feels that their safety or security is threatened at any time, the observation should stop, and the observer should take actions necessary to ensure safety.

5. DATA TO COLLECT

Two essential measures should be assessed in public indoor locations:

- proportion of people who are wearing masks correctly;
- proportion of people who are wearing a mask.

An observed person is wearing a mask if they have a mask over at least part of their mouth and/or nose. They are not wearing a mask if it is entirely under their chin, on the top of their head or dangling from one ear.

An observed person is wearing a mask correctly if the mask covers both the nose and mouth and is secured under the chin. As much as possible, masks should fit snugly against the sides of the face.

Although it is not recommended for someone to touch their mask with their hands except to put it on or take it off, mask touching alone should not change categorization from correct mask use to incorrect mask use.

There are also optional measures that could inform decision-making. However, collecting these optional measures will complicate data collection. Even if some of these measures are of interest, it is advised to initially collect only the two essential measures and then add optional measures if feasible. Optional measures may be challenging to observe accurately, particularly if video surveillance is used as the observation method. Optional measures include:

- Whether circumstances may explain why a person was observed not wearing a mask correctly (i.e., the person was eating or drinking at the time);
- Mask type (i.e., cloth face mask, surgical mask or respirator);
- Role of each observed person in the public place (i.e., store employee versus customer, public transportation rider versus driver);
- Demographics (i.e., age, sex, race, ethnicity) of each observed person. However, observing demographic characteristics and reporting them accurately may be problematic, especially if video footage is used.

6. METHODOLOGIES

One of 15 essential indicators identified by Resolve to Save Lives that can be used to inform decision making is the percentage of the population that wears masks in public indoor locations. However, a jurisdiction may not have the human and/or technical resources to collect and analyze data that could be used to make reliable estimates about the general population's mask-use adherence. Even with resource constraints, it is possible to collect and analyze data on mask use that can help improve COVID-19 response efforts. Depending on the resources available to a jurisdiction, on the local environment (because the environment will determine how far resources can go; fewer observers may be able to gather more data if locations are closer together or frequented by more people) and on the objectives of gathering mask-use data, a methodologic approach can be selected from the table below. Whatever data are collected should be used to inform stakeholders, including the public and public health practitioners, about mask-use adherence.

In order to estimate mask-use adherence systematically, with a known degree of error at a particular confidence level, a simple random sample is usually recommended. Simple random sampling implies that everyone in the population has an equal likelihood of being sampled. Violating the premise of simple random sampling makes extrapolation of findings to the whole population problematic. For example, if observations are only conducted in a convenience sample of neighborhoods that are easy for observers to get to, the data may be biased. The least problematic use of that data would be to estimate mask-use adherence among the population in the sampled neighborhoods only. If those same data were used to estimate mask use among the general population, the precision of those estimates would be unknown. Whatever methodology is selected, it is important to define the

objectives of assessment, to recognize if and how the premise of simple random sampling has been violated and to understand how this may impact the interpretation of the findings.

If data from multiple points of observation will be pooled in order to make estimations of mask-use adherence among a population, clustering should also be taken into account. In this case, clustering refers to the likelihood that people who visit similar locations will display more similar mask-use behaviors than people who visit different locations. Ideally, to avoid the effects of clustering, a single person would be observed in each of many randomly selected locations. Since this is generally not a practical approach, a smaller number of locations may be visited, and more than one person observed within each. In order to then extrapolate findings to a larger population with known precision, the sample size must be inflated by a design effect. The design effect takes into account the extent to which individuals in the same location are similar to each other by building an intracluster coefficient (ICC) into sample size calculations and the uncertainty of the outcomes measured.

While the main objective of assessing mask-use adherence is to generate publicly available data and it may seem that the above details are onerous or unnecessary, it is important that these principles be used to guide selection of locations and people for observation so that there is an acceptable level of confidence that observed data represents reality, and that data can be compared over time, between locations or even between jurisdictions. To aid in this, the circumstances under which data were collected should be fully documented (outside of data collection forms) so that possible biases and uncertainties may be considered.

Methodology A

This methodology is designed to estimate the percentage of people who wear masks correctly within the larger population of all the users of a large venue.

Under Methodology A, a larger location with heavy foot traffic that mixes relatively randomly (e.g., a mass transit system or a large indoor shopping mall) may be selected, and data may be used to draw conclusions about the population that visits that location.

Alternatively, data may be collected in several smaller locations that are similar to each other (e.g., food outlets in an area or post offices in an area) and the data may be pooled to estimate mask-use adherence at the venues sampled. However, this approach is most sound if mask-use behavior does not differ between pooled locations. If rates of mask-use adherence vary between locations, the sample size target should not be split between locations, but rather, each location should be observed and reported separately.

Methodology B

This methodology is an audit technique based on a Lot Quality Assurance Sampling (LQAS) framework. It may be used to identify specific individual locations that are “compliant” versus “non-compliant” with a standard; “non-compliant” locations may be targeted by public health interventions. In this context, a “compliant” location is one in which a minimum proportion of the population is observed to wear a mask (and/or wear a mask correctly); the operational definition of a “non-compliant” location is one in which less than a minimum proportion of the population is observed to wear a mask (and/or wear a mask correctly).

Methodology C

This methodology is based on cluster survey methodology. It will allow estimation, with a known level of precision, of mask-use adherence within a target population. The target population could be the whole population of a jurisdiction or the population within a neighborhood, zip code, community, etc. Locations should be randomly selected from a complete (or as complete as possible) list of the target population's public indoor spaces. The target population could also be a sub-population selected for a specific pattern of indoor space use (e.g., those who attend public sporting events or those who shop at outlet malls,) in which case locations should be randomly selected from a complete list of the indoor spaces of interest.

Implementing the methodology

Select locations for observation sessions

There are many types of indoor locations to consider. The following groupings are adapted from the Commercial Buildings Energy Consumption Survey and are not exhaustive.

Location type	Examples
Education	Schools, colleges/universities, adult education/vocational centers
Food sale/essential retail	Grocery stores, food markets, convenience stores including at Gas stations, pharmacies, "big-box" stores
Food service	Fast food establishments, restaurants (take-out interactions), coffee shops, donut shops, bakeries, other food or confectionary (e.g., ice cream shops, delis)
Hospitality/lodging	Hotels, motels
Retail (standalone)	Any retail store outside of a mall or strip mall location that does not readily fit in another category
Retail (enclosed or mall-based)	Any retail store that is inside a larger building or grouping such as in a mall or strip mall, including connected businesses
Office	Banks, post offices, government offices (e.g. DMV), business offices (e.g. insurance sales, travel agency, construction, plumbing)
Personal care	Gyms, salons, spas, fitness or beauty studios, yoga studios, tanning salons, pet care/ kennel, tattoo/piercing parlor
Public assembly	Libraries, funeral homes, exhibition halls, museums, art galleries, entertainment or recreational spaces other than stadiums
Public transportation	Airports, bus stations, train stations, trains, buses.
Religious worship	Any religious house of worship
Service	Automotive centers, laundromats, repair shops
Other	Any other indoor public space which does not easily fit in one of the above stated categories

Potential locations may be scouted before location choice is finalized. This will help guarantee that location selection is appropriate, that there is adequate and appropriate space for observers to use, that there is adequate foot traffic to generate sufficient data, and that observers will be safe. Bias in location selection can be minimized by identifying the rules and approach to location selection ahead of time and avoiding substitutions when possible. It is advisable to avoid locations where marked pre-existing bias in mask-use adherence is expected, such as in health care settings or dine-in restaurants.

While convenience sampling of locations may be the easiest to carry out, this will provide data that does not lend itself to making comparisons across location types or societal strata such as zip codes or neighborhoods; rather, data may only be used to determine mask-use adherence at individual selected locations (as per Methodology A or B). If the goal of observation is to estimate mask-use adherence within a more general population (per Methodology C), simple random or stratified sampling should be used. In this context, strata will most often refer to a geographic unit such as a zip code or neighborhood. Stratified sampling is the recommended approach if an objective is to compare adherence in different places (neighborhood to neighborhood, location type to location type) as well as to track adherence patterns over time.

Methodology A

Locations may be either:

- Specific individual locations of interest—ideally frequented by large, diverse groups of people (e.g. Department of Motor Vehicles, public transport station, superstore/mall)
- Similar locations within a category of interest—ideally franchised locations or multiple "outlets" of a type of location (e.g. post office, supermarket, fast food enterprise) between which mask use patterns are not expected to differ

Methodology B

Steps in selecting locations:

1. Make a complete list of all locations you wish to sample
2. Stratify locations by chosen criteria. Examples of strata include type of location (see table below), size (large versus small), or geographic strata (neighborhood, zip code, etc.)
3. Based on workload and time considerations, decide how many locations within each stratum can be sampled.
4. Use simple random sampling to select that number of locations from within each stratum.

Methodology C

Steps in selecting location:

1. Determine the target population of interest (e.g., by geography such as zip code or neighborhood, or by type of location, or both).

2. Make a complete list of locations appropriate to the population of interest (e.g., all food stores within a town, or all post offices within five zip codes).
3. Based on workload and time considerations, decide how many locations can be sampled.
4. Use simple random sampling to select that number of locations from the list of locations.

Determine observation session sample size target

In the table below, sample size calculations have been made after selecting levels of error, confidence intervals, number of people to observe per location (cluster), and an ICC per epidemiologic convention and practicality. It has been assumed, to be conservative, that there will be 50% mask-use adherence. For methodology C, two sample size options (number of locations and people per location) are given, guided by two different precision levels. One sample size may be more appropriate if there are limited resources for observation, if locations are far apart, or if there aren't many locations to choose from. The other sample size may be more appropriate if there are more resources for observation and more locations can be visited.

Of note, sample sizes in terms of both locations and people should be targeted per selected data reporting frequency. The recommendation is weekly reporting and weekly repetition of observations/tracking of data. If weekly reporting is selected, sample sizes would be total weekly targets.

	What data may be used to estimate with a known level of precision	Parameters	Number of locations	Number of people in each location
Methodology A	The percentage of people who wear masks/wear masks correctly among all users of one large venue or among users of several similar smaller venues.	5% error, 95% confidence intervals	Any	400 people per location or per group of locations
Methodology B	Identify individual locations that are "compliant" versus "non-compliant" with mask-wearing/correct mask-wearing.	To correctly classify locations as compliant versus non-compliant with 95% one-sided confidence per the following cut-offs: in a fully compliant location, 95% of the people wear masks correctly, and in a fully non-compliant location, 60% or less of the people wear masks correctly.	Any	19 people per location

Methodology C	Mask use/correct mask-use adherence within a target population.	ICC = 0.33 10% error, 95% confidence interval	40	10 people per location (400 total across all locations sampled)
		ICC = 0.33 5% error, 95% confidence interval	150	10 people per location (1500 total across all locations sampled)

***A note about relationships between methodologies and sample sizes:*
If only one methodology is targeted but, due to local circumstances or an abundance of resources, sample size targets for a second methodology are also fulfilled and the basic premises of simple random sampling have not been violated, data may be used to make multiple estimations. For example, if Methodology C with a sample size of 40 locations is chosen and it turns out that it is possible to observe 19 people in each of those 40 locations over the course of the week (or other observation time period), the sample size for Methodology B will also have been fulfilled. If it is possible to observe 400 people in each of those 40 locations over the course of the week, the sample size for Methodology A will also have been fulfilled.

Conduct observation sessions

Whatever methodology is chosen, it is suggested that all steps listed below are followed to help ensure reproducibility and accuracy of results.

Steps to conduct observation sessions:

- Define a length of observation session that will facilitate achievement of the sample size target (this will largely depend on sample size targets and the volume of foot traffic at selected locations).
- Select observation session times distributed randomly or systematically across the opening hours at the location in order to minimize bias.
- Select multiple observation points within each location (e.g., at the entrance, at the check-out line, in an aisle) as behavior may differ between observation points.
- To ensure reproducibility of results, selection of people to observe must be defined ***a priori*** (e.g., every third person passing through one specific checkout line at a supermarket or every tenth person getting on a subway car, etc.)
- Only one person from each social group (e.g., a family or a group of friends) should be sampled in order to maintain the approximation of "interchangeability." In terms of counting per *priori* observation selection rules, one person from each social group should be counted.

Repeat sampling

Repeat sampling to monitor mask-use adherence should be conducted per whatever interval is feasible, but ideally adherence will be monitored on a weekly basis.

Methodology A

Observation sessions should be conducted in the same locations repeatedly so that changes over time can be measured. There may be unforeseen circumstances that necessitate replacing one location with another. If changes are made, there should be adequate documentation of why one location is replaced with another and those changes should be tracked.

Methodology B

The approach to repeat sampling should be determined by the goals of monitoring: if the goal is to monitor mask-use compliance in a set of locations over time, initially selected locations may be visited repeatedly. If the goal is to monitor locations observed to be non-compliant, those locations can be repeatedly visited, and new locations may be evaluated in place of the initially compliant ones.

Methodology C

Assuming that initially selected locations were selected with respect to the target population and were selected randomly in order to adhere to the principle of simple random sampling, the same locations should be repeatedly sampled. If a location unexpectedly needs to be changed, a substitute location may be randomly selected within the list.

7. OBSERVATION FORM

A standardized form should be used for data collection. Electronic forms are recommended, as these facilitate rapid data collation and analysis. If electronic devices cannot be used, printed observation forms, clipboards and writing implements should be provided to observers.

Data from each observation session should include:

- Observer ID
- Date
- Location (name of establishment and address)
- Point of observation (entry, inside, exit)
- Start time
- End time
- Total duration of observation
- Sampling strategy

Essential data to be collected during each observation session includes:

- Number of people observed
- Number of people wearing a mask
- Number of people wearing a mask correctly

Forms may include collection of optional data mentioned above.

8. CALCULATING AND REPORTING MASK-USE ADHERENCE

The recommended observation time period is one week, but adjustments may be made per available resources and goals of mask-use adherence observation. It is important that individual locations are not identifiable from the way data are reported.

Formulas for calculating adherence percentages:

- Mask-use adherence percentage = people wearing masks / total people observed x 100
- Correct mask-use adherence percentage = people wearing masks correctly / total people observed x 100

Methodology A

The following should be reported for each observation time period:

- Number of people observed
- Number of people wearing masks
- Number of people wearing masks correctly
- Overall adherence percentages

It should be made clear that the numbers reported may not be representative of an entire population but, rather, represent mask-use adherence observed in select locations. The adherence percentage can be reported per location type unless that would facilitate identification of the specific location in which observations were conducted.

Methodology B

The following data should be reported per observation time period:

- Number of locations compliant with mask-wearing / number of locations inspected
- Number of locations compliant with correct mask-wearing / number of locations inspected

Data should not be reported publicly by individual location. However, each individual location may be fed back their results.

Methodology C

The following should be reported for each observation time period:

- Number of people observed
- Number of people wearing masks
- Number of people wearing masks correctly
- Overall adherence percentages