the main objective of this analysis is to find the relation between Human time use data from buerau labor statistics and Mosquito blood meal patterns. Understanding and finding the hidden patterns of humans' exposure to mosquito bites based on different features (factors) like humans working conditions in indoor/outdoor jobs, based on race and ethnicity background, Gender of human, and Income level of people.

In our study, we primarily examined individuals in outdoor jobs. This choice was driven by the understanding that these individuals are more likely to be exposed to mosquito bites than those in indoor occupations.

- we use different races like NH white, Hispanic, NH black, and others
- Male and female in gender category
- income level into low, average, and High-income groups
- we mainly concentrated on two mosquito types (Aedes aegypti and Culex quinquefasciatus) as different mosquito species have different preferences for the day/night when they actively seek blood meals.

Loading libraries

In [1]:

```
## IMPORTS
import importlib
import os
from pathlib import Path
import time

import ipywidgets as widgets
import pandas as pd
import numpy as np
import matplotlib as mpl
import matplotlib.pyplot as plt
import seaborn as sns
from datetime import datetime

import IPython
import lib.utils as _utils
import lib.atus_tools as att
from lib.utils import get_project_logger, config_project_logger, \
    SUCCESS, rotate_ax_labels, get_color_cycle_list, get_x_array_for_barplots

# -------------
_LOGGER = get_project_logger().getChild("ipynb")
# importlib.reload(att)


# %matplotlib widget
# mpl.rcParams["pdf.fonttype"] = 42  # Make text editable in exported pdfs
```

```
[atus] DEBUG: `rtrend` Logger configured.
```

In [2]:

```
# PARAMETERS
# =========================================

# Preprocessing directory path
# ----------------------------
# --- Baseline
# preproc_dir = Path("outputs/baseline/by_occupation/")
# preproc_dir = Path("outputs/baseline/by_industry/")
preproc_dir = Path("outputs/baseline/with_bootstrap_100/")

# --- Alternative/sensitivity
# preproc_dir = Path("outputs/alternative/income_classes_20-80_occ/")
# preproc_dir = Path("outputs/alternative/income_classes_20-80_ind/")

# --- Devtests
# preproc_dir = Path("outputs/tests/preproc_dev/")
## comment test
# Mosquito diel activity
# ----------------------
mosq_count_fname = Path("mosquito_diel_data/mosqdiel_general_counts.csv")
```

In [5]:

```
def count_folders(directory):
    # Initialize a counter for folders
    folder_count = 0

    # Iterate over each item in the directory
    for item in os.listdir(directory):
        # Check if the item is a folder
        if os.path.isdir(os.path.join(directory, item)):
            # If it's a folder, increment the counter
            folder_count += 1

    return folder_count


def create_folder_if_not_exists(folder_path):
    if not os.path.exists(folder_path):
        os.makedirs(folder_path)
        print(f"Folder '{folder_path}' created successfully.")
    else:
        print(f"Folder '{folder_path}' already exists.")
```

Preprocessing

setting up environment and other basic variables

In [6]:

```
hourly = False
# preproc_dir, hourly = Path("outputs/tests/main_bootstrap_test/"), False
preproc_dir, hourly = preproc_dir, True


# aggr_features = ["all", "income_id"]
# ------------
aggr_features=[
        "all", "income_id", "TUMONTH", "PESEX", "race_ethnicity",
        "is_outdoor_job",  "is_weekend", "job_and_weekend", "income_and_weekend"
        "occupation_exposure_id",
    ]

# IMPORT PREPROCESSED DATA
# ========================
importlib.reload(att)

# ---

env = att.get_default_atus_env()

# === Load mosquito diel activity
mosq_diel_df = pd.read_csv(mosq_count_fname, index_col=[0, 1])
mosq_diel_df.columns.name = "hour"

mosq_diel_df #hourly mosquito count for different locations

env = att.get_default_atus_env()

# Load original ensemble
main_pre = att.ATUSPreprocBunch.from_dir(
    preproc_dir, aggr_features=aggr_features,
    import_raw=False,
    raise_on_not_found=False,
    tseries_is_hourly=hourly,

)
```

In [7]:

```
# === Create ATUS environment
fname = main_pre.meta_dict.get("atus_environment_path", None)
if fname is not None:
    myenv = att.ATUSEnvironment.from_env_file(fname)
else:
    _LOGGER.warn("No ATUS env path in metadata. Will create default environment.
    myenv = att.get_default_atus_env()

# === Load state metadata
fips_df = att.import_fips_df(main_pre.meta_dict["fips_fname"])

# ---
main_pre.meta_dict["use_aggr_features"]
```

Out[7]:

```
['all',
 'PESEX',
 'TUMONTH',
 'is_weekend',
 'race_ethnicity',
 'income_id',
 'occupation_exposure_id',
 'is_outdoor_job',
 {'job_and_weekend': ['is_outdoor_job', 'is_weekend']},
 {'income_and_weekend': ['income_id', 'is_weekend']},
 {'raceth_and_weekend': ['race_ethnicity', 'is_weekend']},
 {'sex_and_weekend': ['PESEX', 'is_weekend']}]
```

loading bootstrap data into data frames

Loading all the Data into multi-index data frame

this is how entire data of humans lookslike

each column in data from fifth column is each hour of day and their exposure

- i_boot: is the experiment number
- exp_id: is exposure at that time if they are indoor or outdoor
- all: is including all features available

In [10]:
```
boot_df
```

Out[10]:

				2023-01-01 00:00:00	2023-01-01 01:00:00	2023-01-01 02:00:00	2023-01-01 03:00:00	2023-01-01 04:00:00	05
i_boot	**exp_id**	**state_name**	**all**						
0	**0**	**Alabama**	**True**	0.992003	0.994709	0.994570	0.991746	0.982672	0.9
		Alaska	**True**	1.000000	0.996233	1.000000	1.000000	0.976880	0.9
		Arizona	**True**	0.980498	0.984619	0.985288	0.983310	0.980919	0.9
		Arkansas	**True**	0.983057	0.990840	0.997904	0.997259	0.987528	0.9
		California	**True**	0.980852	0.986388	0.990805	0.989254	0.984261	0.9
...	**...**	**...**	**...**	...	...	...	...	...	
99	**2**	**Virginia**	**True**	0.020948	0.019635	0.015993	0.011331	0.021152	0.0
		Washington	**True**	0.014276	0.011419	0.009219	0.007146	0.007063	0.0
		West Virginia	**True**	0.028590	0.010801	0.010796	0.006759	0.020064	0.0
		Wisconsin	**True**	0.024790	0.019661	0.013481	0.012551	0.013427	0.0
		Wyoming	**True**	0.016121	0.005374	0.000000	0.018815	0.010311	0.0

15300 rows × 24 columns

In [23]:
```
# # ===================================
# # SELECTABLE FEATURE - Time series
# # ===================================
# exp_id = 1  # Outdoor only

# # feat_name, id_to_name = "income_id", lambda x: env.income_id_to_name[x]
# # feat_name, id_to_name = "PESEX", lambda x: env.pesex_to_name[x]
# # feat_name, id_to_name = "race_ethnicity", lambda x: env.race_id_to_name[x]
# # # feat_name, id_to_name = "occupation_exposure_id", lambda x: f"{env.actype_
# # feat_name, id_to_name = "all", lambda x: "Everyone" if x else "No-one [:"
# # feat_name, id_to_name = "is_outdoor_job", lambda x: "Outdoor job" if x else
# # feat_name, id_to_name = "is_weekend", lambda x: "Weekends" if x else "Weekda
# # --- Composite features
# # feat_name, id_to_name = "job_and_weekend", lambda x: f"{'outdoor' if x[0] el
# # feat_name, id_to_name = "income_and_weekend", lambda x: f"{env.income_id_to_
# # feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x[0]==1 el
# # feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x[0]==1 el
# # feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x==1 else
# feat_name, id_to_name = "raceth_and_weekend", lambda x: f"{env.race_id_to_name

# main_df = main_pre.feat_aggr_df_dict[feat_name]
# if hourly:
#     main_df.columns.name = "hour"
# else:
#     main_df = att.aggregate_exp_minutes_to_hours(df)

# main_df_wted = att.aggregate_states_series_with_weights(
#     main_df, main_pre.slice_data_df["weight"],
# #     use_level_values=["California", "Florida", "Texas"],
# #     use_level_values=["Florida"],
# )

# boot_df = pd.concat(
#     [boot_pre_list[i].feat_aggr_df_dict[feat_name] for i in samples],
#     axis=0,
#     keys=samples,
#     names=["i_boot"],
# )

# if hourly:
#     boot_df.columns.name = "hour"
# else:
#     boot_df = att.aggregate_exp_minutes_to_hours(df)

# boot_df_wted = att.aggregate_states_series_with_weights(
#     boot_df, main_pre.slice_data_df["weight"],
# #     use_level_values=["California", "Florida", "Texas"],
# #     use_level_values=["Florida"],
# )


# boot_df_grp=boot_df_wted.xs(exp_id, level="exp_id")
# boot_df_mean=boot_df_grp.groupby(['race_ethnicity','is_weekend']).mean().T.sum

# bootstraped=boot_df_grp.T.sum().to_frame()
# bootstraped.rename(columns={0:'valu'},inplace=True)


# df=bootstraped.reset_index()
# mapping={True:'weekend',False:'weekeday'}
# df['weeker']=df['is_weekend'].map(mapping)
# df['race_ethnicity']=df['race_ethnicity'].map(id_to_name)
# # df['weeker']=df['weeker'].astype('category')
# sns.barplot(data=df,x='race_ethnicity',y='valu',hue='weeker',estimator=np.mean
# plt.ylabel("avg num of hours spent outside")
# # display(samples_df)
```

figure 1

mosq randomization using poission for Quinque and ageptyi

In [11]:

```
# Test mosquito diel data uncertainty
# ==================================
# --- Parameters
# num_samples = 100  # Must match the number of bootstrap samples
```

```
num_samples = num_folders # calculated from the UDF for bootstrap data (based on

# data_label = "miami-aegypti"
# data_label = "brownsville-quinque"
data_labels=["locations-aegypti","brownsville-quinque"]

zero_shift = 5  # Force data to have at least this number of mosquitoes

# ============

def random_mosq_genrator_poission(mosq_diel_df,mosq_label):
    """/*#**********************
    this function uses the provided data frame and mosq_label to generate random
    and returns the dataframe
    */"""
    # --- Select a single mosquito diel data (sum over all months)
    mosq_sr = mosq_diel_df.groupby("data_label").sum().loc[mosq_label]
    # --- Add a shift to small values
    mosq_sr.loc[:] = np.maximum(mosq_sr.values, zero_shift)

    # --- Generate uncertainty for all hours
    rng = np.random.default_rng(seed=1)
    rnd_mosq_array = rng.poisson(mosq_sr.values, size=(num_samples, mosq_sr.shap
    #   ^ ^ Signature: rnd_mosq_array[i_sample, i_hour] = value

    # --- Turn into a data frame
    rnd_mosq_df = pd.DataFrame(rnd_mosq_array)
    rnd_mosq_df.index.name = "sample"
    rnd_mosq_df.columns.name = "hour"

    return rnd_mosq_df


# random mosquito generation for each type of mosquito
df_rnd_mosq_ageypti=random_mosq_genrator_poission(mosq_diel_df,"locations-aegypt
df_rnd_mosq_quinque=random_mosq_genrator_poission(mosq_diel_df,"brownsville-quin

#   ^ ^ Signature: rnd_mosq_df.loc[i_sample, i_hour] = value

#row-each sample
# column each hor
# RESULT: the `rnd_mosq_df` dataframe contains an ensemble of
#  diel activity values for each hour. You can use it to generate
#  the figures of the paper.
```

we sampled the data using bootstrap for mosquito populations for 24 hrs of the day

In [12]:

```
df_rnd_mosq_ageypti
```

Out[12]:

hour	0	1	2	3	4	5	6	7	8	9	...	14	15	16	17
sample															
0	152	149	153	125	155	97	221	1044	1043	834	...	119	170	195	395
1	167	173	132	128	159	93	212	1134	1082	826	...	127	167	197	384
2	153	147	131	130	142	107	234	1108	1069	771	...	122	149	176	390
3	148	161	141	120	156	106	225	1111	1044	846	...	118	184	206	396
4	137	147	112	112	144	107	260	1041	1022	791	...	103	160	187	379
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
95	133	147	138	120	139	92	228	1050	1018	839	...	138	185	206	348
96	160	172	141	123	151	110	206	1087	1010	885	...	116	175	190	403
97	146	172	151	133	146	90	227	1094	1058	795	...	111	167	199	399
98	147	160	124	136	152	90	239	1093	1095	752	...	104	184	195	372
99	146	152	142	118	158	97	233	1111	1077	751	...	107	153	173	411

100 rows × 24 columns

In [15]:

```
def mosq_uncertainity_plot(mosq_diel_df,mosq_label,rnd_mosq_df):
    mosq_sr = mosq_diel_df.groupby("data_label").sum().loc[mosq_label]
    # --- Add a shift to small values
    mosq_sr.loc[:] = np.maximum(mosq_sr.values, zero_shift)
    fig, ax = plt.subplots()

    # --- Generated uncertainty
    ax.plot(rnd_mosq_df.mean(axis=0), label="mean")
    ax.fill_between(
        x=rnd_mosq_df.columns,  # Hours
        y1=rnd_mosq_df.quantile(q=0.025),  # Lower quantile
        y2=rnd_mosq_df.quantile(q=0.975),  # Upper quantile
        # Formatting options
        alpha=0.5, color="C1", linewidth=0,
    )

    # --- Original data: mosquito diel activity without uncertainty
    # ax.plot(mosq_sr, label="Original data")


    ax.legend()


    return fig, ax
```

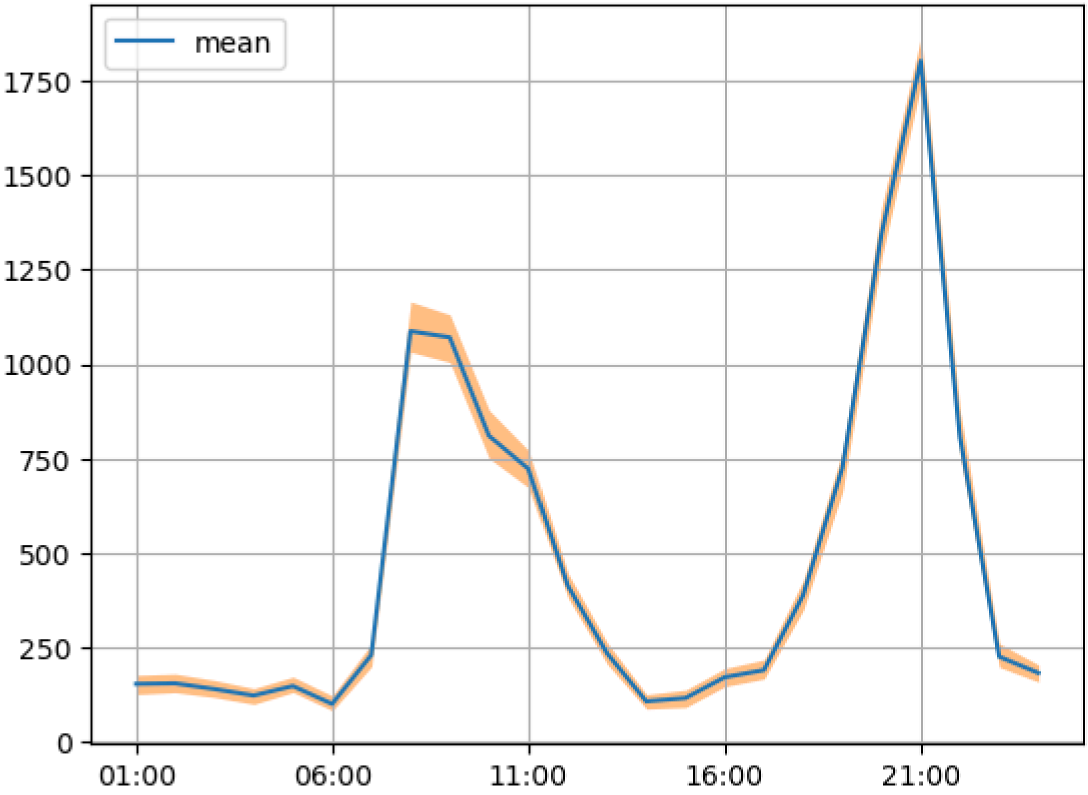
before normalization

this is number of ageptyi mosquito moment patterns in each hour of the day with shaded are being confidence intervals

- it implies that these species are mostly active in the morning around 8:00 am to 10:00 am and late in the evening 7:00 pm to 10:00 pm

In [16]:

```
do_save_fig=False

fig, ax = mosq_uncertainity_plot(mosq_diel_df,"locations-aegypti",df_rnd_mosq_ag

ax.xaxis.set_major_formatter(mpl.dates.DateFormatter("%d:%H"))
plt.grid(True)
plt.figure(figsize=(20,15))
plt.show()  # If you want to display the plot

if do_save_fig:
    create_folder_if_not_exists('tmp_figs/preprint')
    fig.savefig(f"tmp_figs/preprint/fig1_locations_aegypti.pdf")
```



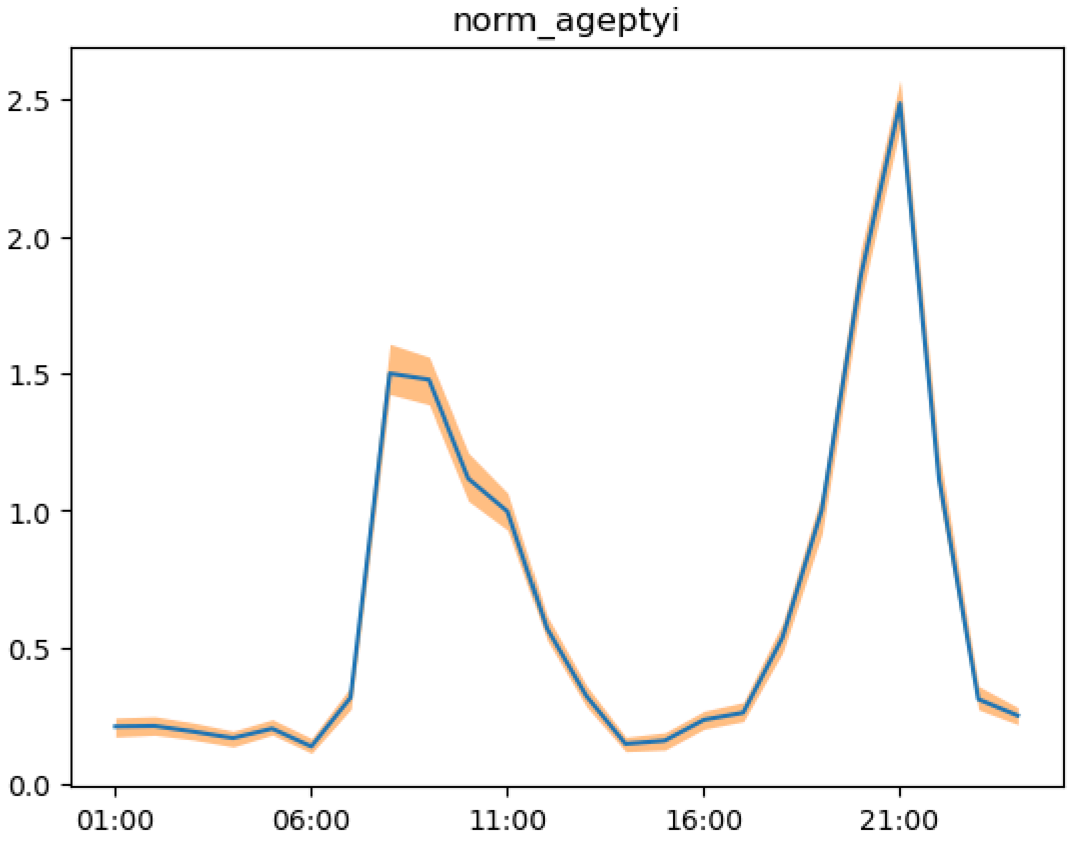
```
<Figure size 2000x1500 with 0 Axes>
```

normailizing the population

ageptyi post normalization

In [17]:

```
temp_val=df_rnd_mosq_ageypti.mean(axis=0).loc[18] ## 6pm value
norm_df_rnd_mosq_ageypti=df_rnd_mosq_ageypti/temp_val

do_save_fig=True

fig, ax = mosq_uncertainity_plot(mosq_diel_df,"locations-aegypti",norm_df_rnd_mo

ax.xaxis.set_major_formatter(mpl.dates.DateFormatter("%d:%H"))
plt.title("norm_ageptyi")
# plt.grid(True)
plt.gca().legend().remove()
plt.figure(figsize=(20,15))
plt.show()  # If you want to display the plot

if do_save_fig:
    create_folder_if_not_exists('tmp_figs/preprint')
    fig.savefig(f"tmp_figs/preprint/fig1_locations_norm_aegypti.pdf")
```



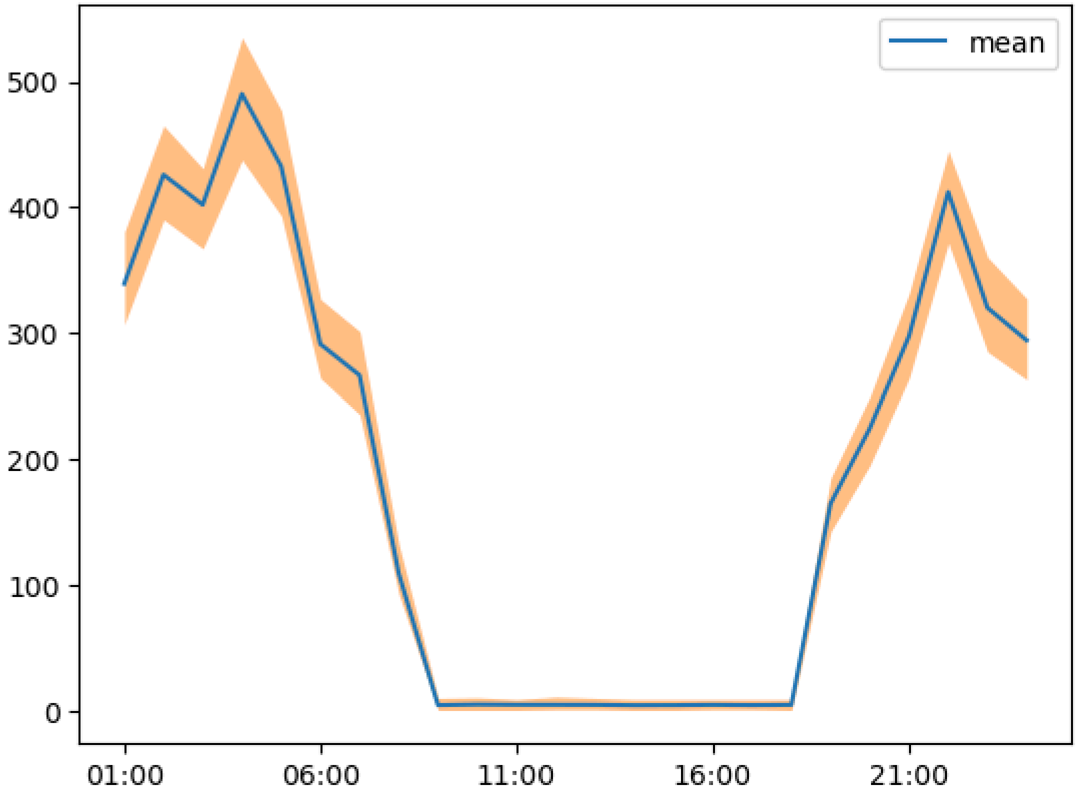
```
<Figure size 2000x1500 with 0 Axes>
Folder 'tmp_figs/preprint' already exists.
```

quinque pre normalization

this is number of quinque mosquito moment patterns in each hour of the day with shaded are being confidence intervals

- it implies that these species are mostly active early in the morning and late in the evening

```
In [18]: # %matplotlib widget
fig, ax = mosq_uncertainity_plot(mosq_diel_df,"brownsville-quinque",df_rnd_mosq_
ax.xaxis.set_major_formatter(mpl.dates.DateFormatter("%d:%H"))

plt.show()  # If you want to display the plot

if do_save_fig:
    create_folder_if_not_exists('tmp_figs/preprint')
    fig.savefig(f"tmp_figs/preprint/fig1_brownsville-quinque.pdf")
```

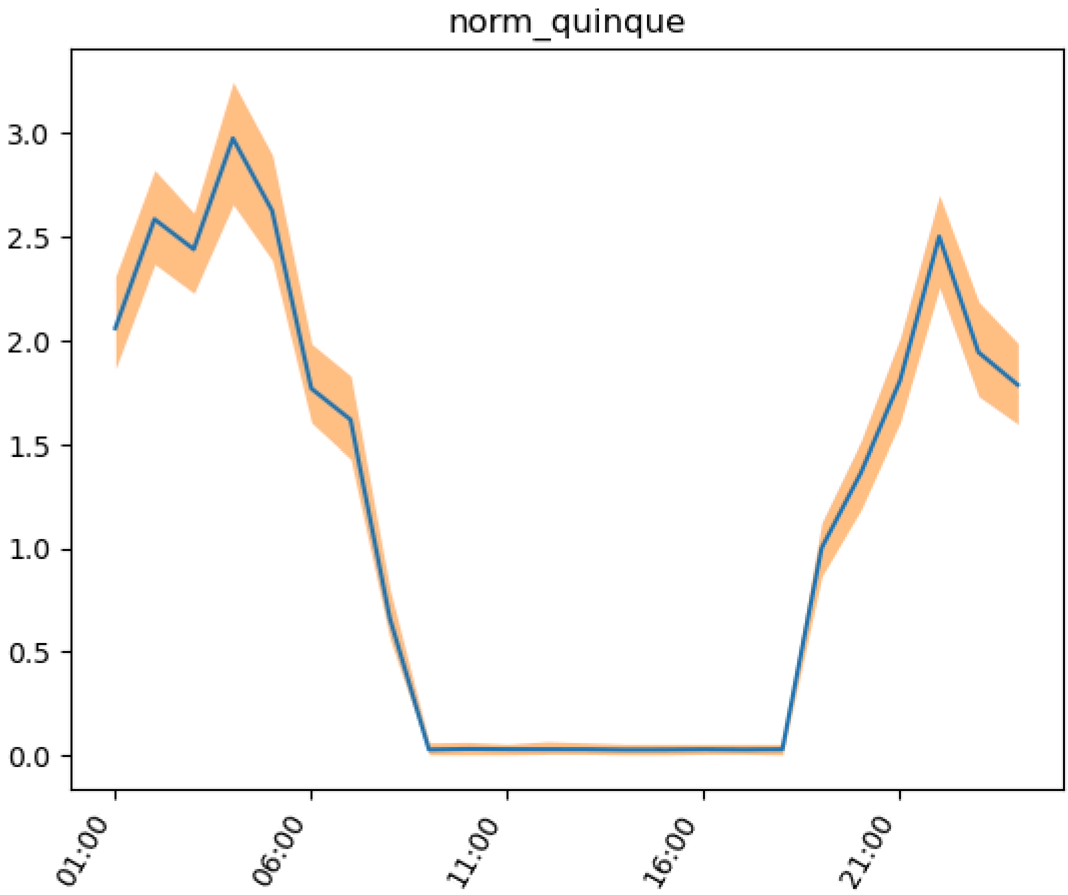


```
Folder 'tmp_figs/preprint' already exists.
```

quinque post normalization

In [19]:

```
temp_val=df_rnd_mosq_quinque.mean(axis=0).loc[18] ## quinque value at 6pm
norm_df_rnd_mosq_quinque=df_rnd_mosq_quinque/temp_val

do_save_fig=True

fig, ax = mosq_uncertainity_plot(mosq_diel_df,"locations-aegypti",norm_df_rnd_mo
rotate_ax_labels(ax)
ax.xaxis.set_major_formatter(mpl.dates.DateFormatter("%d:%H"))

plt.title("norm_quinque")
# plt.grid(True)
plt.gca().legend().remove()
plt.figure(figsize=(20,15))
plt.ion()
plt.show()  # If you want to display the plot

if do_save_fig:
    create_folder_if_not_exists('tmp_figs/preprint')
    fig.savefig(f"tmp_figs/preprint/fig1_locations_Norm_quinque.pdf")
```



```
<Figure size 2000x1500 with 0 Axes>
Folder 'tmp_figs/preprint' already exists.
```

Human timeuse timeseries

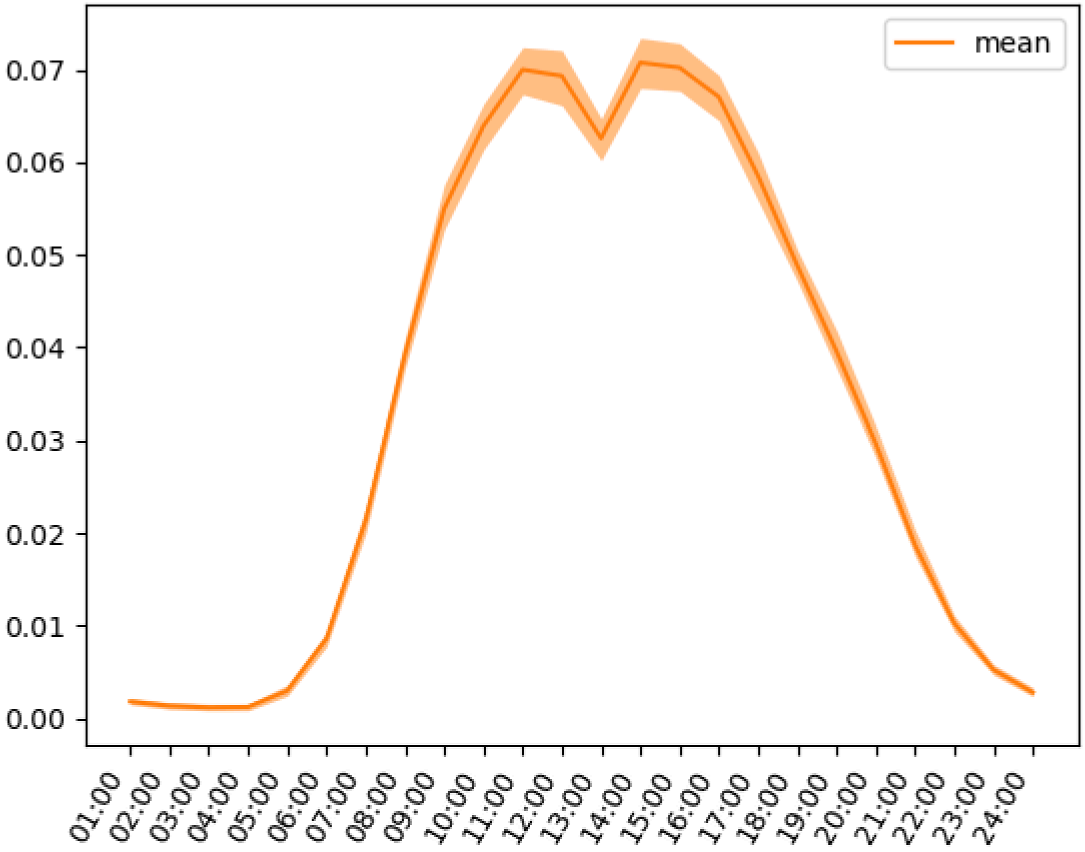
In [20]:

```
# ====================================
# SELECTABLE FEATURE - Time series
# ====================================
exp_id = 1  # Outdoor only

# feat_name, id_to_name = "income_id", lambda x: env.income_id_to_name[x]
# feat_name, id_to_name = "PESEX", lambda x: env.pesex_to_name[x]
# feat_name, id_to_name = "race_ethnicity", lambda x: env.race_id_to_name[x]
# # feat_name, id_to_name = "occupation_exposure_id", lambda x: f"{env.actype_id
feat_name, id_to_name = "all", lambda x: "Everyone" if x else "No-one [:"
# feat_name, id_to_name = "is_outdoor_job", lambda x: "Outdoor job" if x else "I
# feat_name, id_to_name = "is_weekend", lambda x: "Weekends" if x else "Weekdays
# --- Composite features
# feat_name, id_to_name = "job_and_weekend", lambda x: f"{'outdoor' if x[0] else
# feat_name, id_to_name = "income_and_weekend", lambda x: f"{env.income_id_to_na
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x[0]==1 else
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x[0]==1 else
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x==1 else 'f
# feat_name, id_to_name = "raceth_and_weekend", lambda x: f"{env.race_id_to_name

main_df = main_pre.feat_aggr_df_dict[feat_name]
if hourly:
    main_df.columns.name = "hour"
else:
    main_df = att.aggregate_exp_minutes_to_hours(df)

main_df_wted = att.aggregate_states_series_with_weights(
    main_df, main_pre.slice_data_df["weight"],
#     use_level_values=["California", "Florida", "Texas"],
#     use_level_values=["Florida"],
)

boot_df = pd.concat(
    [boot_pre_list[i].feat_aggr_df_dict[feat_name] for i in samples],
    axis=0,
    keys=samples,
    names=["i_boot"],
)

if hourly:
    boot_df.columns.name = "hour"
else:
    boot_df = att.aggregate_exp_minutes_to_hours(df)

boot_df_wted = att.aggregate_states_series_with_weights(
    boot_df, main_pre.slice_data_df["weight"],
#     use_level_values=["California", "Florida", "Texas"],
#     use_level_values=["Florida"],
)


boot_df_grp=boot_df_wted.xs(exp_id, level="exp_id")
```

This is humans time use patterns outdoors. it implies that generally humans more outdoor during the day .

In [22]:
```
fig, ax = plt.subplots()

# --- Generated uncertainty
ax.plot(boot_df_grp.mean(axis=0), label="mean", color="C1")
ax.fill_between(
    x=boot_df_grp.columns,  # Hours
    y1=boot_df_grp.quantile(q=0.025),  # Lower quantile
    y2=boot_df_grp.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.5, color="C1", linewidth=0,
)
rotate_ax_labels(ax)
ax.xaxis.set_major_formatter(mpl.dates.DateFormatter("%d:%H"))
plt

ax.legend()

if do_save_fig:
    create_folder_if_not_exists('tmp_figs/preprint')
    fig.savefig(f"tmp_figs/preprint/fig1_human_all.pdf")
```

```
Folder 'tmp_figs/preprint' already exists.
```



```
In [20]: hour_list=boot_df_grp.columns.to_list()
         hours=[]
         for i in range(len(hour_list)):
         # Parse the string into a datetime object
             dt_object = datetime.strptime(hour_list[i], "%Y-%m-%d %H:%M:%S")
             # Extract the hour component
             hours.append(dt_object.hour)
```

normalizing the mosquito and human crossover

In [21]:

```
boot_df_grp=boot_df_wted.xs(exp_id, level="exp_id")
boot_df_grp.columns=hours
boot_df_grp.columns.name = "hour"
human_df=boot_df_grp.droplevel("all")


##### normalizing with 6pm value of each mosq_human cross over


human_X_mosq_ageptyi=human_df*df_rnd_mosq_ageypti
human_X_mosq_quinque=human_df*df_rnd_mosq_quinque

## using value at 6pm so commenting max value
# max_human_x_mosq_ageptyi=human_X_mosq_ageptyi.mean(axis=0).max()
# max_human_x_mosq_quinque=human_X_mosq_quinque.mean(axis=0).max()

norm_6_pm_ageptyi=human_X_mosq_ageptyi.mean(axis=0).loc[18]
norm_6_pm_quinque=human_X_mosq_quinque.mean(axis=0).loc[18]

norm_human_X_mosq_ageptyi=human_X_mosq_ageptyi/norm_6_pm_ageptyi
norm_human_X_mosq_quinque=human_X_mosq_quinque/norm_6_pm_quinque
```

In [22]:

```
norm_6_pm_quinque
```

Out[22]:

```
6.532225619729022
```

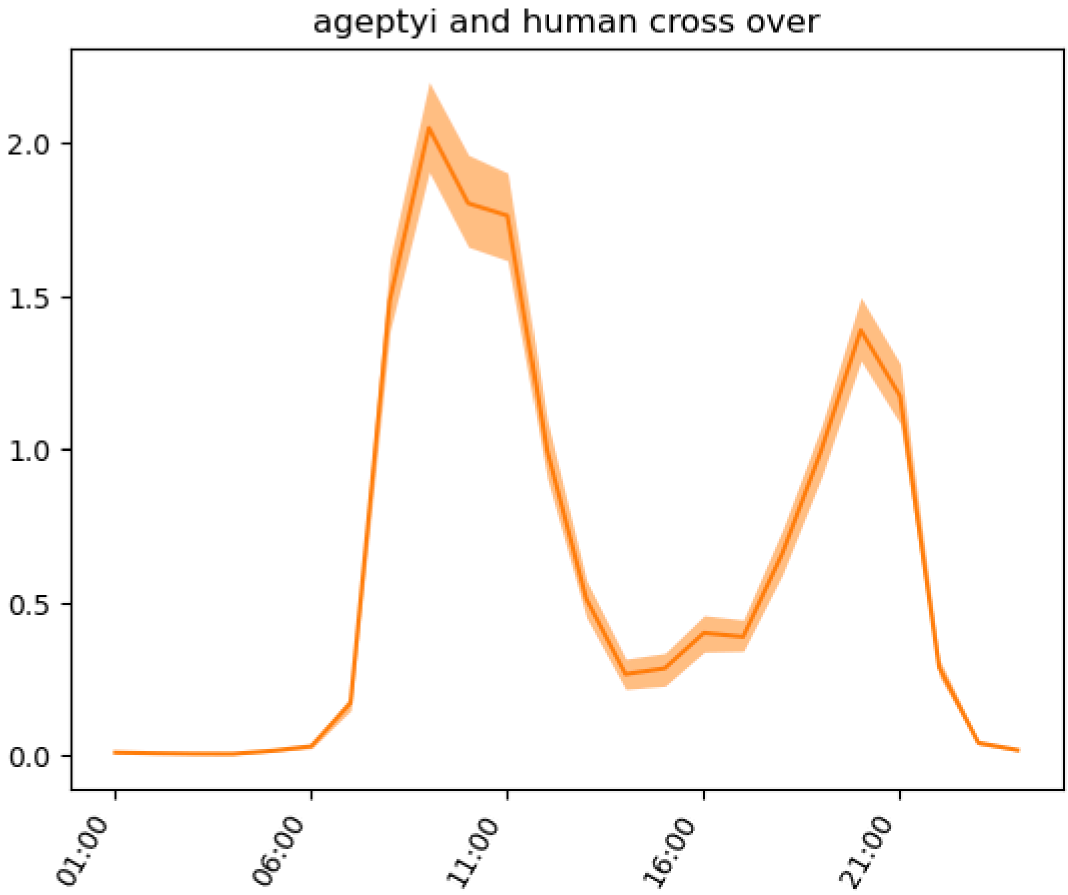
figure 2

ageptyi and human cross over

In [24]:

```
fig, ax = plt.subplots()

# --- Generated uncertainty
ax.plot(norm_human_X_mosq_ageptyi.mean(axis=0), label="mean", color="C1")
ax.fill_between(
    x=norm_human_X_mosq_ageptyi.columns,  # Hours
    y1=norm_human_X_mosq_ageptyi.quantile(q=0.025),  # Lower quantile
    y2=norm_human_X_mosq_ageptyi.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.5, color="C1", linewidth=0,
)

rotate_ax_labels(ax)
ax.xaxis.set_major_formatter(mpl.dates.DateFormatter("%d:%H"))
plt.title('ageptyi and human cross over')

# ax.legend()

if do_save_fig:
    create_folder_if_not_exists('tmp_figs/preprint')
    fig.savefig(f"tmp_figs/preprint/fig2_norm_human_X_norm_mosq_ageptyi.pdf")
```

```
Folder 'tmp_figs/preprint' already exists.
```



quinque and human cross over

In [25]:
```
fig, ax = plt.subplots()

# --- Generated uncertainty
ax.plot(norm_human_X_mosq_quinque.mean(axis=0), label="mean", color="C1")
ax.fill_between(
    x=norm_human_X_mosq_quinque.columns,  # Hours
    y1=norm_human_X_mosq_quinque.quantile(q=0.025),  # Lower quantile
    y2=norm_human_X_mosq_quinque.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.5, color="C1", linewidth=0,
)
rotate_ax_labels(ax)
ax.xaxis.set_major_formatter(mpl.dates.DateFormatter("%d:%H"))
plt.title('quinque and human cross over')

# ax.legend()

if do_save_fig:
    create_folder_if_not_exists('tmp_figs/preprint')
    fig.savefig(f"tmp_figs/preprint/fig2_norm_human_X_norm_mosq_quinque.pdf")
```

```
Folder 'tmp_figs/preprint' already exists.
```

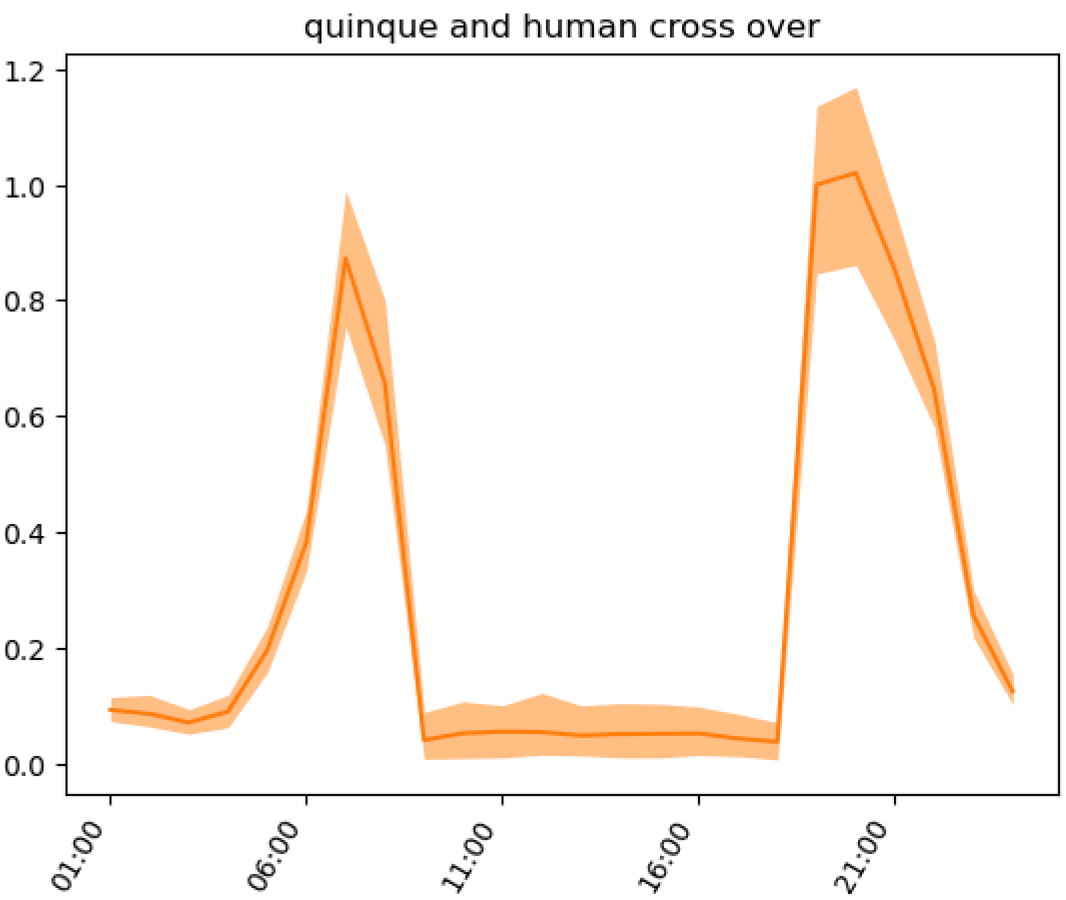


figure 3

calculating overall population for normalization

In [26]:

```
# =====================================
# SELECTABLE FEATURE - Time series
# =====================================
exp_id = 1  # Outdoor only

# feat_name, id_to_name = "income_id", lambda x: env.income_id_to_name[x]
# feat_name, id_to_name = "PESEX", lambda x: env.pesex_to_name[x]
# feat_name, id_to_name = "race_ethnicity", lambda x: env.race_id_to_name[x]
# # feat_name, id_to_name = "occupation_exposure_id", lambda x: f"{env.actype_id
feat_name, id_to_name = "all", lambda x: "Everyone" if x else "No-one [:"
# feat_name, id_to_name = "is_outdoor_job", lambda x: "Outdoor job" if x else "I
# feat_name, id_to_name = "is_weekend", lambda x: "Weekends" if x else "Weekdays
# --- Composite features
# feat_name, id_to_name = "job_and_weekend", lambda x: f"{'outdoor' if x[0] else
# feat_name, id_to_name = "income_and_weekend", lambda x: f"{env.income_id_to_na
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x[0]==1 else
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x[0]==1 else
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x==1 else 'f
# feat_name, id_to_name = "raceth_and_weekend", lambda x: f"{env.race_id_to_name

main_df = main_pre.feat_aggr_df_dict[feat_name]
if hourly:
    main_df.columns.name = "hour"
else:
    main_df = att.aggregate_exp_minutes_to_hours(df)

main_df_wted = att.aggregate_states_series_with_weights(
    main_df, main_pre.slice_data_df["weight"],
#     use_level_values=["California", "Florida", "Texas"],
#     use_level_values=["Florida"],
)

boot_df = pd.concat(
    [boot_pre_list[i].feat_aggr_df_dict[feat_name] for i in samples],
    axis=0,
    keys=samples,
    names=["i_boot"],
)

if hourly:
    boot_df.columns.name = "hour"
else:
    boot_df = att.aggregate_exp_minutes_to_hours(df)

boot_df_wted = att.aggregate_states_series_with_weights(
    boot_df, main_pre.slice_data_df["weight"],
#     use_level_values=["California", "Florida", "Texas"],
#     use_level_values=["Florida"],
)


boot_df_grp=boot_df_wted.xs(exp_id, level="exp_id")


boot_df_grp=boot_df_wted.xs(exp_id, level="exp_id")
boot_df_grp.columns=hours
boot_df_grp.columns.name = "hour"
human_df=boot_df_grp.droplevel("all")


human_X_mosq_ageptyi=human_df*df_rnd_mosq_ageypti
human_X_mosq_quinque=human_df*df_rnd_mosq_quinque


mean_overall_human_pop_with_mosq_ageptyi=human_X_mosq_ageptyi.sum(axis=1).mean()
mean_overall_human_pop_with_mosq_quinque=human_X_mosq_quinque.sum(axis=1).mean()
```

with ageptyi

income_id

In [61]:

```
mean_overall_human_pop_with_mosq_ageptyi
```

Out[61]:

```
424.1350491249157
```

In [62]:

```
all_df['feat']=all_df[feat_name]
all_df.drop(feat_name,inplace=True,axis=1)
all_df
```

Out[62]:

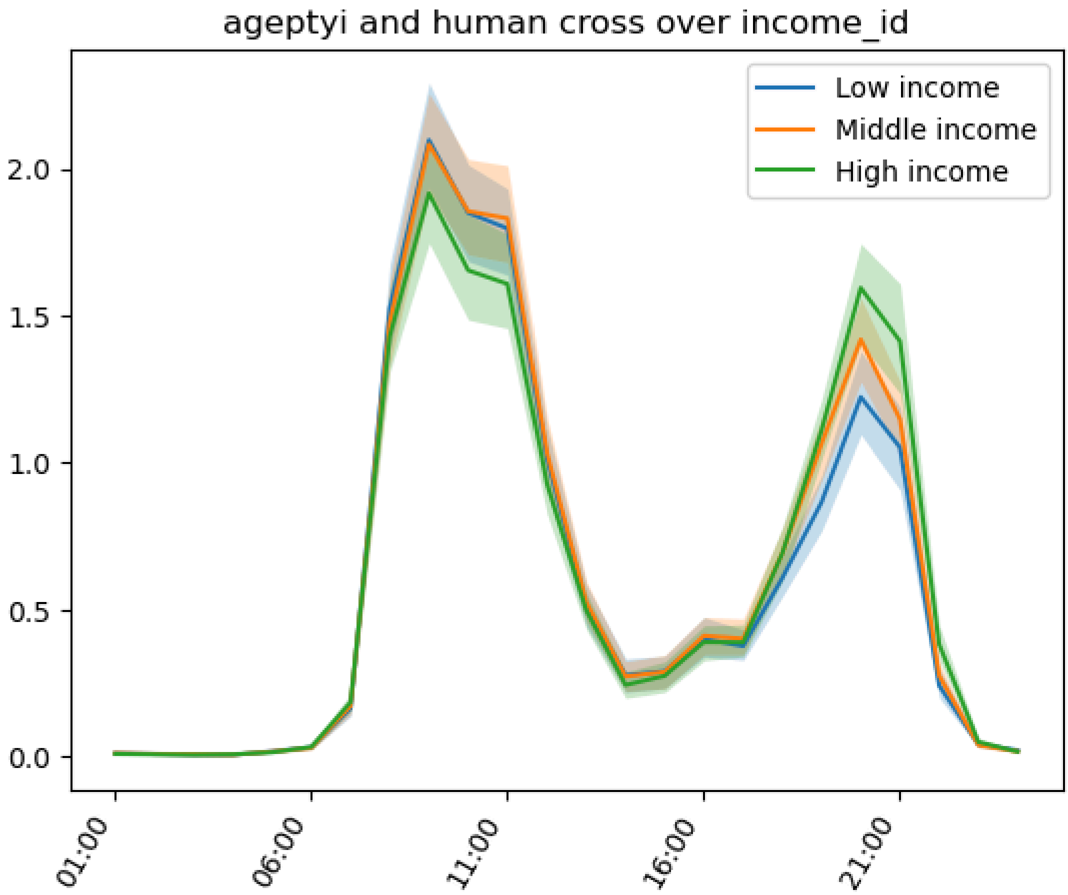
	mean_val	lower	upper	feat
0	0.975768	0.044687	0.047678	Low income
1	1.019631	0.043386	0.047949	Middle income
2	1.003594	0.055596	0.051985	High income

time series

In [63]:

```
mosq_human_df1=pd.concat(
    [boot_df_grp.xs(i,level=feat_name).mul(mosq_type_df) for i in lvls],
    axis=0,
    keys=lvls,
    names=[feat_name],
)
t_plot=mosq_human_df1/norm_6_pm_ageptyi

# for i in lvls:
i0=t_plot.xs(0,level=feat_name)
i1=t_plot.xs(1,level=feat_name)
i2=t_plot.xs(2,level=feat_name)


fig, ax = plt.subplots()

map_names=lvls.map(id_to_name)
# --- Generated uncertainty
ax.plot(i0.mean(axis=0), label=map_names[0], color="C0")
ax.plot(i1.mean(axis=0), label=map_names[1], color="C1")
ax.plot(i2.mean(axis=0), label= map_names[2], color="C2")
ax.fill_between(
    x=i0.columns,  # Hours
    y1=i0.quantile(q=0.025),  # Lower quantile
    y2=i0.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C0", linewidth=0,
)

ax.fill_between(
    x=i1.columns,  # Hours
    y1=i1.quantile(q=0.025),  # Lower quantile
    y2=i1.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C1", linewidth=0,
)

ax.fill_between(
    x=i2.columns,  # Hours
    y1=i2.quantile(q=0.025),  # Lower quantile
    y2=i2.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C2", linewidth=0,
)


rotate_ax_labels(ax)
ax.xaxis.set_major_formatter(mpl.dates.DateFormatter("%d:%H"))
plt.title(f"ageptyi and human cross over {feat_name}")
```

```
ax.legend()
plt.show()
if True:
    create_folder_if_not_exists('tmp_figs/preprint')
    fig.savefig(f"tmp_figs/preprint/ageptyi_{feat_name}_timeseries.pdf")
```



```
Folder 'tmp_figs/preprint' already exists.
```

In [64]:

```
multi_feat_df=all_df.copy()
```

Gender

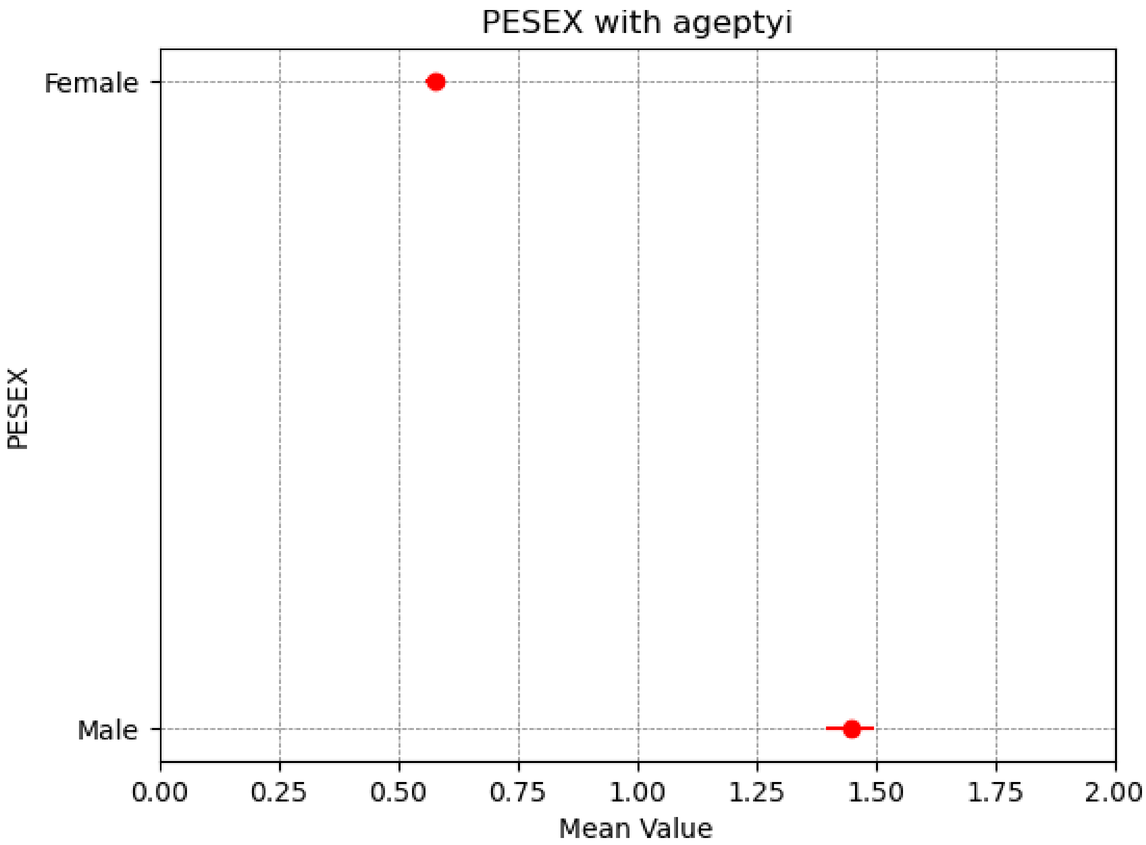
In [65]:

```
# ====================================
# SELECTABLE FEATURE - Time series
# ====================================
exp_id = 1  # Outdoor only

# feat_name, id_to_name = "income_id", lambda x: env.income_id_to_name[x]
feat_name, id_to_name = "PESEX", lambda x: env.pesex_to_name[x]
# feat_name, id_to_name = "race_ethnicity", lambda x: env.race_id_to_name[x]
# # feat_name, id_to_name = "occupation_exposure_id", lambda x: f"{env.actype_id
# feat_name, id_to_name = "all", lambda x: "Everyone" if x else "No-one [:"
# feat_name, id_to_name = "is_outdoor_job", lambda x: "Outdoor job" if x else "I
# feat_name, id_to_name = "is_weekend", lambda x: "Weekends" if x else "Weekdays
# --- Composite features
# feat_name, id_to_name = "job_and_weekend", lambda x: f"{'outdoor' if x[0] else
# feat_name, id_to_name = "income_and_weekend", lambda x: f"{env.income_id_to_na
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x[0]==1 else
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x[0]==1 else
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x==1 else 'f
# feat_name, id_to_name = "raceth_and_weekend", lambda x: f"{env.race_id_to_name
```

```
main_df = main_pre.feat_aggr_df_dict[feat_name]
if hourly:
    main_df.columns.name = "hour"
else:
    main_df = att.aggregate_exp_minutes_to_hours(df)

main_df_wted = att.aggregate_states_series_with_weights(
    main_df, main_pre.slice_data_df["weight"],
#     use_level_values=["California", "Florida", "Texas"],
#     use_level_values=["Florida"],
)

boot_df = pd.concat(
    [boot_pre_list[i].feat_aggr_df_dict[feat_name] for i in samples],
    axis=0,
    keys=samples,
    names=["i_boot"],
)

if hourly:
    boot_df.columns.name = "hour"
else:
    boot_df = att.aggregate_exp_minutes_to_hours(df)

boot_df_wted = att.aggregate_states_series_with_weights(
    boot_df, main_pre.slice_data_df["weight"],
#     use_level_values=["California", "Florida", "Texas"],
#     use_level_values=["Florida"],
)


boot_df_grp=boot_df_wted.xs(exp_id, level="exp_id")


boot_df_grp=boot_df_wted.xs(exp_id, level="exp_id")
boot_df_grp.columns=hours
boot_df_grp.columns.name = "hour"

lvls=boot_df_grp.index.get_level_values(feat_name).unique()
mosq_type_df=df_rnd_mosq_ageypti
mosq_human_df=pd.concat(
    [boot_df_grp.xs(i,level=feat_name).mul(mosq_type_df).sum(axis=1) for i in lv
    axis=0,
    keys=lvls,
    names=[feat_name],
).to_frame()

norm_ageypti_human_df=mosq_human_df/mean_overall_human_pop_with_mosq_ageptyi
con_df=norm_ageypti_human_df.groupby(feat_name).mean()
q_25=norm_ageypti_human_df.groupby(feat_name).quantile(0.025)
q_95=norm_ageypti_human_df.groupby(feat_name).quantile(0.925)

con_df['mean_val']=con_df[0]
q_25['q25']=q_25[0]
q_95['q95']=q_95[0]

con_df.drop(0,inplace=True,axis=1)
q_25.drop(0,inplace=True,axis=1)
q_95.drop(0,inplace=True,axis=1)
```

```
quantile=pd.merge(q_95,q_25,how='inner',on=feat_name)
# quantile['diff']=quantile['q95']-quantile['q25']

# quantile.drop(columns=['q25','q95'],inplace=True)

all_df=pd.merge(con_df,quantile,how='inner',on=feat_name)
all_df['lower']=all_df['mean_val']-all_df['q25']
all_df['upper']=all_df['q95']-all_df['mean_val']
all_df.drop(columns=['q25','q95'],inplace=True)
asymentric_err_bar=[all_df['lower'].values,all_df['upper'].values]


all_df=all_df.T

all_df.columns=all_df.columns.map(id_to_name)
all_df=all_df.T
all_df=all_df.reset_index()

fig,ax=plt.subplots()
ax.errorbar(y=all_df[feat_name], x=all_df['mean_val'],xerr=asymentric_err_bar, c

ax.set_xlim(0, 2)

ax.set_xlabel('Mean Value')
ax.set_ylabel(feat_name)
ax.set_title(f"{feat_name} with ageptyi")
# Customizing grid lines
ax.grid(True, linestyle='--', color='gray', linewidth=0.5)
fig.show()

if do_save_fig:
    create_folder_if_not_exists('tmp_figs/preprint')
    plt.savefig(f"tmp_figs/preprint/fig3_{feat_name}_with_ageptyi.pdf")
```

```
Folder 'tmp_figs/preprint' already exists.
```



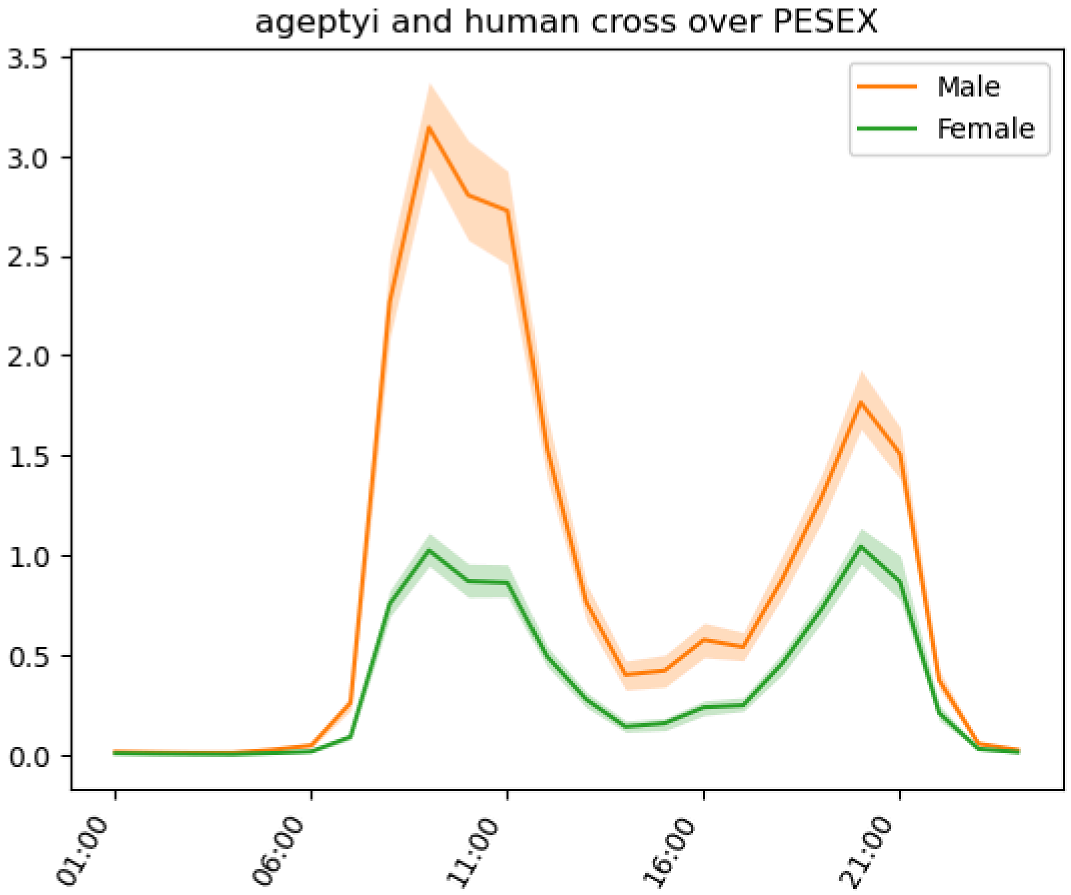
In [66]:
```
print(norm_ageypti_human_df.groupby(feat_name).mean())
print(norm_ageypti_human_df.groupby(feat_name).quantile(q=0.025))
print(norm_ageypti_human_df.groupby(feat_name).quantile(q=0.975))
```

```
              0
PESEX          
1      1.451462
2      0.578059
              0
PESEX          
1      1.396267
2      0.556485
              0
PESEX          
1      1.503747
2      0.602069
```

time series

In [67]:
```
mosq_human_df1=pd.concat(
    [boot_df_grp.xs(i,level=feat_name).mul(mosq_type_df) for i in lvls],
    axis=0,
    keys=lvls,
    names=[feat_name],
)

t_plot=mosq_human_df1/norm_6_pm_ageptyi

# for i in lvls:
# i0=t_plot.xs(0,level=feat_name)
i1=t_plot.xs(1,level=feat_name)
i2=t_plot.xs(2,level=feat_name)
```

```python
fig, ax = plt.subplots()

map_names=lvls.map(id_to_name)
# --- Generated uncertainty
# ax.plot(i0.mean(axis=0), label="mean i0", color="C0")
ax.plot(i1.mean(axis=0), label=map_names[0], color="C1")
ax.plot(i2.mean(axis=0), label=map_names[1], color="C2")
# ax.fill_between(
#     x=i0.columns,  # Hours
#     y1=i0.quantile(q=0.025),  # Lower quantile
#     y2=i0.quantile(q=0.975),  # Upper quantile
#     # Formatting options
#     alpha=0.25, color="C0", linewidth=0,
# )

ax.fill_between(
    x=i1.columns,  # Hours
    y1=i1.quantile(q=0.025),  # Lower quantile
    y2=i1.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C1", linewidth=0,
)

ax.fill_between(
    x=i2.columns,  # Hours
    y1=i2.quantile(q=0.025),  # Lower quantile
    y2=i2.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C2", linewidth=0,
)


rotate_ax_labels(ax)
ax.xaxis.set_major_formatter(mpl.dates.DateFormatter("%d:%H"))
plt.title(f"ageptyi and human cross over {feat_name}")

ax.legend()
plt.show()
if True:
    create_folder_if_not_exists('tmp_figs/preprint')
    fig.savefig(f"tmp_figs/preprint/ageptyi_{feat_name}_timeseries.pdf")
```



```
Folder 'tmp_figs/preprint' already exists.
```

In [68]:

```
all_df['feat']=all_df[feat_name]
all_df.drop(feat_name,inplace=True,axis=1)

multi_feat_df=pd.concat([multi_feat_df,all_df],ignore_index=True)
multi_feat_df
```

Out[68]:

	mean_val	lower	upper	feat
0	0.975768	0.044687	0.047678	Low income
1	1.019631	0.043386	0.047949	Middle income
2	1.003594	0.055596	0.051985	High income
3	1.451462	0.055195	0.044660	Male
4	0.578059	0.021574	0.017805	Female

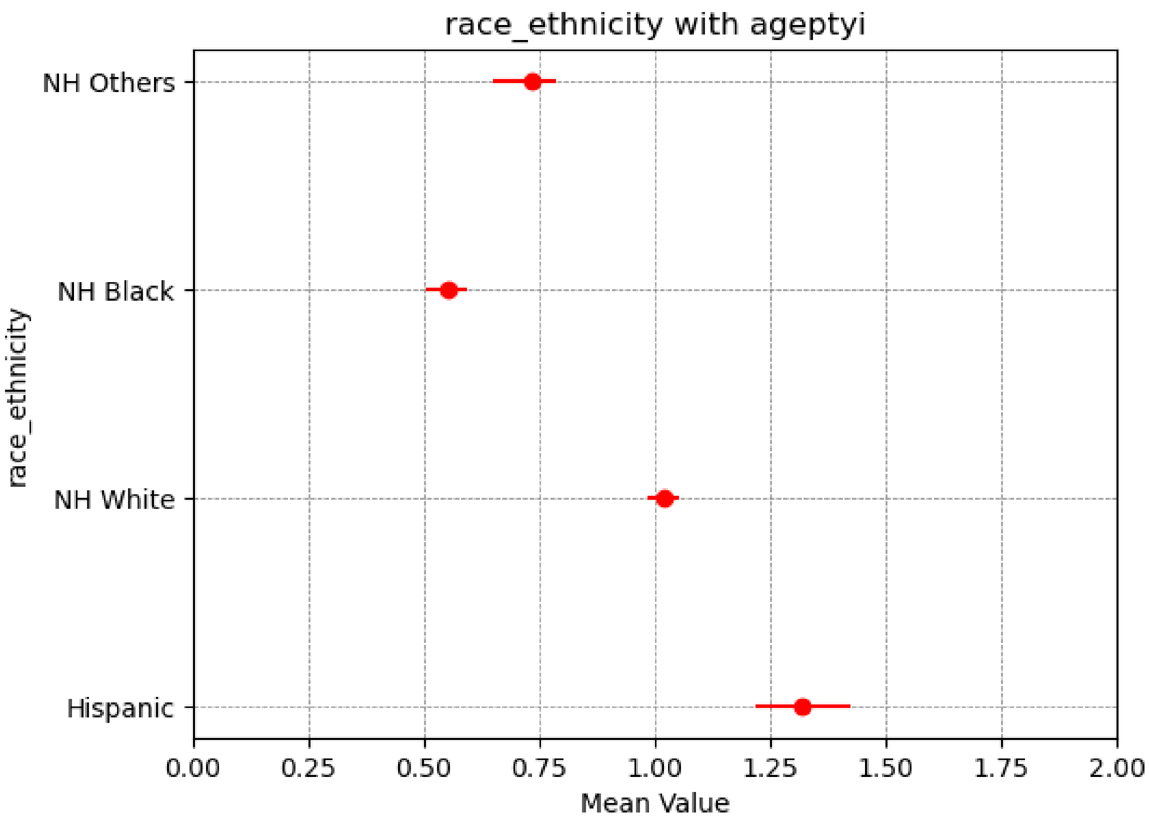
race and ethnicity

In [69]:

```
# ====================================
# SELECTABLE FEATURE - Time series
# ====================================
exp_id = 1  # Outdoor only

# feat_name, id_to_name = "income_id", lambda x: env.income_id_to_name[x]
# feat_name, id_to_name = "PESEX", lambda x: env.pesex_to_name[x]
feat_name, id_to_name = "race_ethnicity", lambda x: env.race_id_to_name[x]
# # feat_name, id_to_name = "occupation_exposure_id", lambda x: f"{env.actype_id
# feat_name, id_to_name = "all", lambda x: "Everyone" if x else "No-one [:"
# feat_name, id_to_name = "is_outdoor_job", lambda x: "Outdoor job" if x else "I
# feat_name, id_to_name = "is_weekend", lambda x: "Weekends" if x else "Weekdays
# --- Composite features
# feat_name, id_to_name = "job_and_weekend", lambda x: f"{'outdoor' if x[0] else
# feat_name, id_to_name = "income_and_weekend", lambda x: f"{env.income_id_to_na
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x[0]==1 else
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x[0]==1 else
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x==1 else 'f
# feat_name, id_to_name = "raceth_and_weekend", lambda x: f"{env.race_id_to_name

main_df = main_pre.feat_aggr_df_dict[feat_name]
if hourly:
    main_df.columns.name = "hour"
else:
    main_df = att.aggregate_exp_minutes_to_hours(df)

main_df_wted = att.aggregate_states_series_with_weights(
    main_df, main_pre.slice_data_df["weight"],
#     use_level_values=["California", "Florida", "Texas"],
#     use_level_values=["Florida"],
)

boot_df = pd.concat(
    [boot_pre_list[i].feat_aggr_df_dict[feat_name] for i in samples],
    axis=0,
    keys=samples,
    names=["i_boot"],
)

if hourly:
    boot_df.columns.name = "hour"
else:
    boot_df = att.aggregate_exp_minutes_to_hours(df)

boot_df_wted = att.aggregate_states_series_with_weights(
    boot_df, main_pre.slice_data_df["weight"],
#     use_level_values=["California", "Florida", "Texas"],
#     use_level_values=["Florida"],
)


boot_df_grp=boot_df_wted.xs(exp_id, level="exp_id")


boot_df_grp=boot_df_wted.xs(exp_id, level="exp_id")
boot_df_grp.columns=hours
boot_df_grp.columns.name = "hour"

lvls=boot_df_grp.index.get_level_values(feat_name).unique()
mosq_type_df=df_rnd_mosq_ageypti
mosq_human_df=pd.concat(
    [boot_df_grp.xs(i,level=feat_name).mul(mosq_type_df).sum(axis=1) for i in lv
    axis=0,
    keys=lvls,
    names=[feat_name],
).to_frame()

norm_ageypti_human_df=mosq_human_df/mean_overall_human_pop_with_mosq_ageptyi
con_df=norm_ageypti_human_df.groupby(feat_name).mean()
q_25=norm_ageypti_human_df.groupby(feat_name).quantile(0.025)
```

```
q_95=norm_ageypti_human_df.groupby(feat_name).quantile(0.925)

con_df['mean_val']=con_df[0]
q_25['q25']=q_25[0]
q_95['q95']=q_95[0]

con_df.drop(0,inplace=True,axis=1)
q_25.drop(0,inplace=True,axis=1)
q_95.drop(0,inplace=True,axis=1)

quantile=pd.merge(q_95,q_25,how='inner',on=feat_name)
# quantile['diff']=quantile['q95']-quantile['q25']

# quantile.drop(columns=['q25','q95'],inplace=True)

all_df=pd.merge(con_df,quantile,how='inner',on=feat_name)
all_df['lower']=all_df['mean_val']-all_df['q25']
all_df['upper']=all_df['q95']-all_df['mean_val']
all_df.drop(columns=['q25','q95'],inplace=True)
asymentric_err_bar=[all_df['lower'].values,all_df['upper'].values]


all_df=all_df.T

all_df.columns=all_df.columns.map(id_to_name)
all_df=all_df.T
all_df=all_df.reset_index()

fig,ax=plt.subplots()
ax.errorbar(y=all_df[feat_name], x=all_df['mean_val'],xerr=asymentric_err_bar, c

ax.set_xlim(0, 2)

ax.set_xlabel('Mean Value')
ax.set_ylabel(feat_name)
ax.set_title(f"{feat_name} with ageptyi")
# Customizing grid lines
ax.grid(True, linestyle='--', color='gray', linewidth=0.5)
fig.show()

if do_save_fig:
    create_folder_if_not_exists('tmp_figs/preprint')
    plt.savefig(f"tmp_figs/preprint/fig3_{feat_name}_with_ageptyi.pdf")
```

```
Folder 'tmp_figs/preprint' already exists.
```



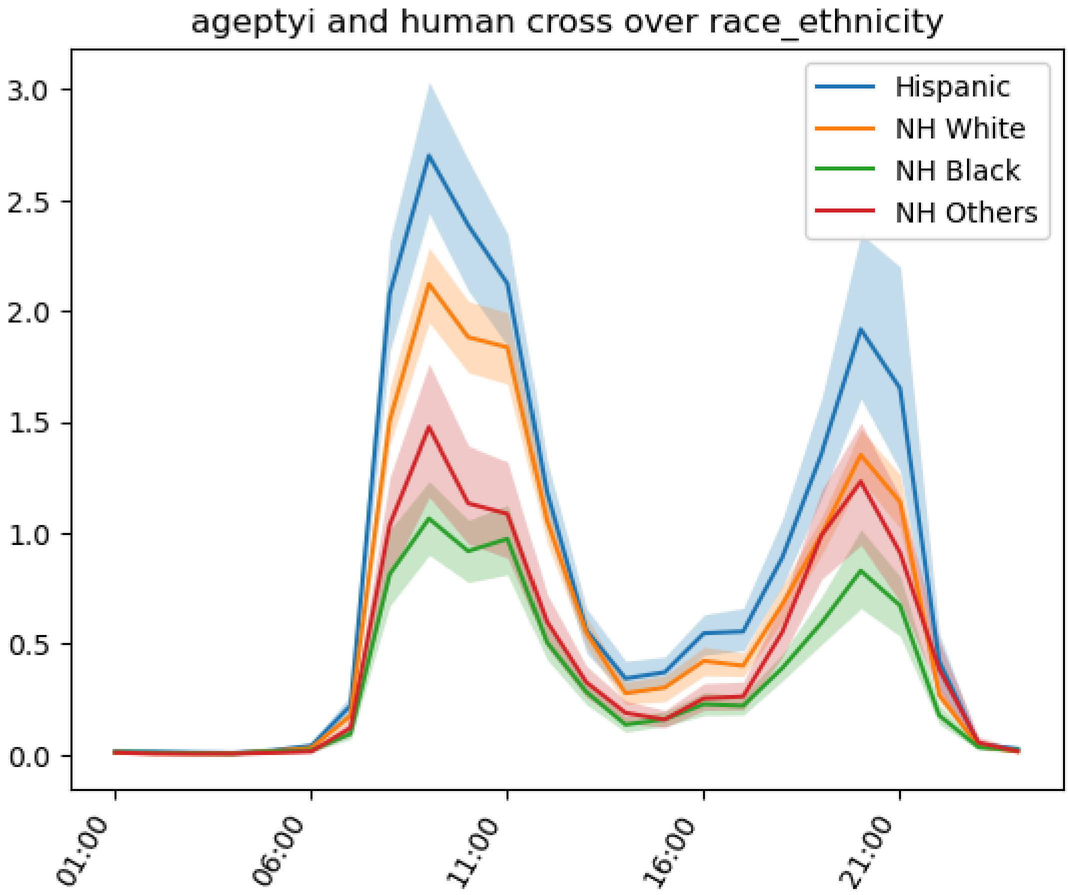
In [38]:
```python
print(norm_ageypti_human_df.groupby(feat_name).mean())
print(norm_ageypti_human_df.groupby(feat_name).quantile(q=0.025))
print(norm_ageypti_human_df.groupby(feat_name).quantile(q=0.975))
```

```
                       0
race_ethnicity          
0               1.318038
1               1.020166
2               0.552871
3               0.732128
                       0
race_ethnicity          
0               1.217316
1               0.982990
2               0.504463
3               0.647160
                       0
race_ethnicity          
0               1.442923
1               1.061249
2               0.614976
3               0.808584
```

time series

In [70]:
```python
mosq_human_df1=pd.concat(
    [boot_df_grp.xs(i,level=feat_name).mul(mosq_type_df) for i in lvls],
    axis=0,
    keys=lvls,
    names=[feat_name],
)

t_plot=mosq_human_df1/norm_6_pm_ageptyi
```

```
# for i in lvls:
i0=t_plot.xs(0,level=feat_name)
i1=t_plot.xs(1,level=feat_name)
i2=t_plot.xs(2,level=feat_name)
i3=t_plot.xs(3,level=feat_name)

fig, ax = plt.subplots()

map_names=lvls.map(id_to_name)

# --- Generated uncertainty
ax.plot(i0.mean(axis=0), label=map_names[0], color="C0")
ax.plot(i1.mean(axis=0), label=map_names[1], color="C1")
ax.plot(i2.mean(axis=0), label=map_names[2], color="C2")
ax.plot(i3.mean(axis=0), label=map_names[3], color="C3")

ax.fill_between(
    x=i0.columns,  # Hours
    y1=i0.quantile(q=0.025),  # Lower quantile
    y2=i0.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C0", linewidth=0,
)

ax.fill_between(
    x=i1.columns,  # Hours
    y1=i1.quantile(q=0.025),  # Lower quantile
    y2=i1.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C1", linewidth=0,
)

ax.fill_between(
    x=i2.columns,  # Hours
    y1=i2.quantile(q=0.025),  # Lower quantile
    y2=i2.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C2", linewidth=0,
)

ax.fill_between(
    x=i3.columns,  # Hours
    y1=i3.quantile(q=0.025),  # Lower quantile
    y2=i3.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C3", linewidth=0,
)


rotate_ax_labels(ax)
ax.xaxis.set_major_formatter(mpl.dates.DateFormatter("%d:%H"))
plt.title(f"ageptyi and human cross over {feat_name}")

ax.legend()
plt.show()
if True:
    create_folder_if_not_exists('tmp_figs/preprint')
    fig.savefig(f"tmp_figs/preprint/ageptyi_{feat_name}_timeseries.pdf")
```



```
Folder 'tmp_figs/preprint' already exists.
```

In [71]:

```
all_df['feat']=all_df[feat_name]
all_df.drop(feat_name,inplace=True,axis=1)

multi_feat_df=pd.concat([multi_feat_df,all_df],ignore_index=True)
multi_feat_df
```

Out[71]:

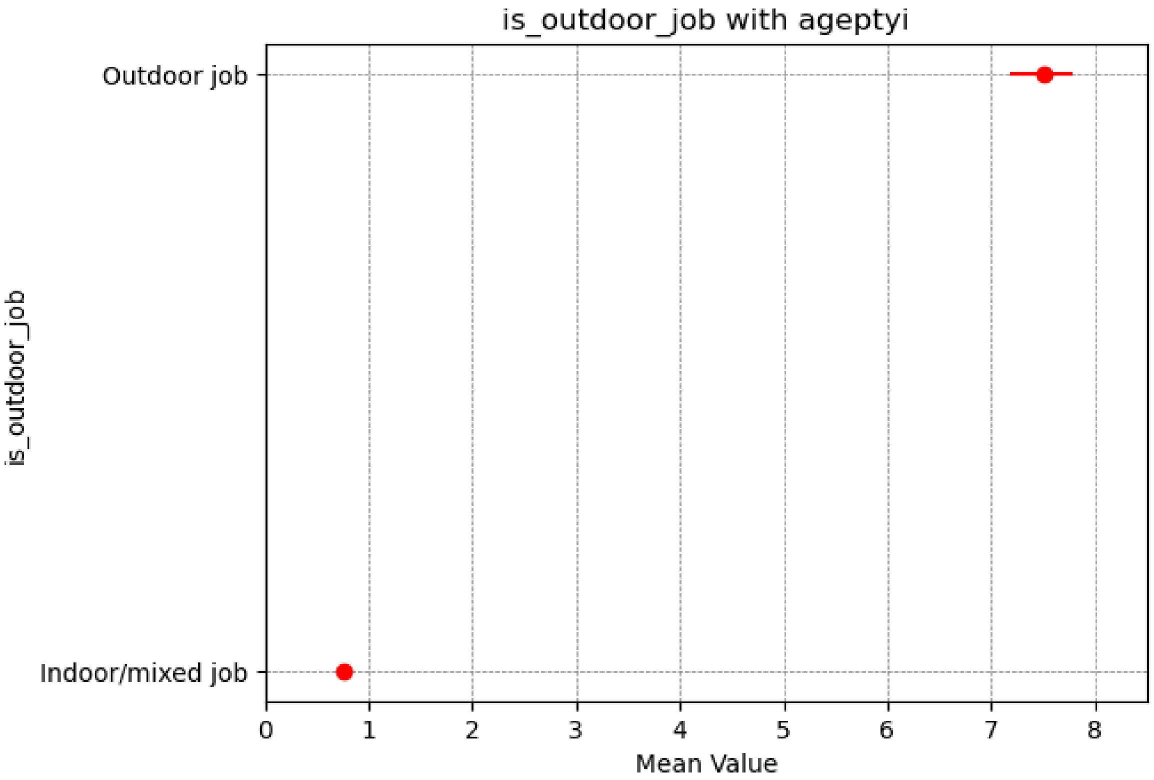
	mean_val	lower	upper	feat
0	0.975768	0.044687	0.047678	Low income
1	1.019631	0.043386	0.047949	Middle income
2	1.003594	0.055596	0.051985	High income
3	1.451462	0.055195	0.044660	Male
4	0.578059	0.021574	0.017805	Female
5	1.318038	0.100722	0.103246	Hispanic
6	1.020166	0.037176	0.030502	NH White
7	0.552871	0.048407	0.038760	NH Black
8	0.732128	0.084968	0.052949	NH Others

is_outdoor_job

In [72]:

```
# ===================================
# SELECTABLE FEATURE - Time series
# ===================================
exp_id = 1  # Outdoor only

# feat_name, id_to_name = "income_id", lambda x: env.income_id_to_name[x]
# feat_name, id_to_name = "PESEX", lambda x: env.pesex_to_name[x]
# feat_name, id_to_name = "race_ethnicity", lambda x: env.race_id_to_name[x]
# feat_name, id_to_name = "occupation_exposure_id", lambda x: f"{env.actype_id_t
# feat_name, id_to_name = "all", lambda x: "Everyone" if x else "No-one [:"
feat_name, id_to_name = "is_outdoor_job", lambda x: "Outdoor job" if x else "Ind
# feat_name, id_to_name = "is_weekend", lambda x: "Weekends" if x else "Weekdays
# --- Composite features
# feat_name, id_to_name = "job_and_weekend", lambda x: f"{'outdoor' if x[0] else
# feat_name, id_to_name = "income_and_weekend", lambda x: f"{env.income_id_to_na
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x[0]==1 else
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x[0]==1 else
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x==1 else 'f
# feat_name, id_to_name = "raceth_and_weekend", lambda x: f"{env.race_id_to_name

main_df = main_pre.feat_aggr_df_dict[feat_name]
if hourly:
    main_df.columns.name = "hour"
else:
    main_df = att.aggregate_exp_minutes_to_hours(df)

main_df_wted = att.aggregate_states_series_with_weights(
    main_df, main_pre.slice_data_df["weight"],
#     use_level_values=["California", "Florida", "Texas"],
#     use_level_values=["Florida"],
)

boot_df = pd.concat(
    [boot_pre_list[i].feat_aggr_df_dict[feat_name] for i in samples],
    axis=0,
    keys=samples,
    names=["i_boot"],
)

if hourly:
    boot_df.columns.name = "hour"
else:
    boot_df = att.aggregate_exp_minutes_to_hours(df)

boot_df_wted = att.aggregate_states_series_with_weights(
    boot_df, main_pre.slice_data_df["weight"],
#     use_level_values=["California", "Florida", "Texas"],
#     use_level_values=["Florida"],
)


boot_df_grp=boot_df_wted.xs(exp_id, level="exp_id")


boot_df_grp=boot_df_wted.xs(exp_id, level="exp_id")
boot_df_grp.columns=hours
boot_df_grp.columns.name = "hour"

lvls=boot_df_grp.index.get_level_values(feat_name).unique()
mosq_type_df=df_rnd_mosq_ageypti
mosq_human_df=pd.concat(
    [boot_df_grp.xs(i,level=feat_name).mul(mosq_type_df).sum(axis=1) for i in lv
    axis=0,
    keys=lvls,
    names=[feat_name],
).to_frame()

norm_ageypti_human_df=mosq_human_df/mean_overall_human_pop_with_mosq_ageptyi
con_df=norm_ageypti_human_df.groupby(feat_name).mean()
q_25=norm_ageypti_human_df.groupby(feat_name).quantile(0.025)
q_95=norm_ageypti_human_df.groupby(feat_name).quantile(0.925)

con_df['mean_val']=con_df[0]
q_25['q25']=q_25[0]
q_95['q95']=q_95[0]

con_df.drop(0,inplace=True,axis=1)
q_25.drop(0,inplace=True,axis=1)
q_95.drop(0,inplace=True,axis=1)

quantile=pd.merge(q_95,q_25,how='inner',on=feat_name)
# quantile['diff']=quantile['q95']-quantile['q25']

# quantile.drop(columns=['q25','q95'],inplace=True)

all_df=pd.merge(con_df,quantile,how='inner',on=feat_name)
all_df['lower']=all_df['mean_val']-all_df['q25']
all_df['upper']=all_df['q95']-all_df['mean_val']
all_df.drop(columns=['q25','q95'],inplace=True)
asymentric_err_bar=[all_df['lower'].values,all_df['upper'].values]


all_df=all_df.T

all_df.columns=all_df.columns.map(id_to_name)
all_df=all_df.T
all_df=all_df.reset_index()

fig,ax=plt.subplots()
ax.errorbar(y=all_df[feat_name], x=all_df['mean_val'],xerr=asymentric_err_bar, c

ax.set_xlim(0, 8.5)

ax.set_xlabel('Mean Value')
ax.set_ylabel(feat_name)
ax.set_title(f"{feat_name} with ageptyi")
# Customizing grid lines
ax.grid(True, linestyle='--', color='gray', linewidth=0.5)
fig.show()

if do_save_fig:
    create_folder_if_not_exists('tmp_figs/preprint')
    plt.savefig(f"tmp_figs/preprint/fig3_{feat_name}_with_ageptyi.pdf")
```

```
Folder 'tmp_figs/preprint' already exists.
```



In [73]:

```
print(norm_ageypti_human_df.groupby(feat_name).mean())
print(norm_ageypti_human_df.groupby(feat_name).quantile(q=0.025))
print(norm_ageypti_human_df.groupby(feat_name).quantile(q=0.975))
```

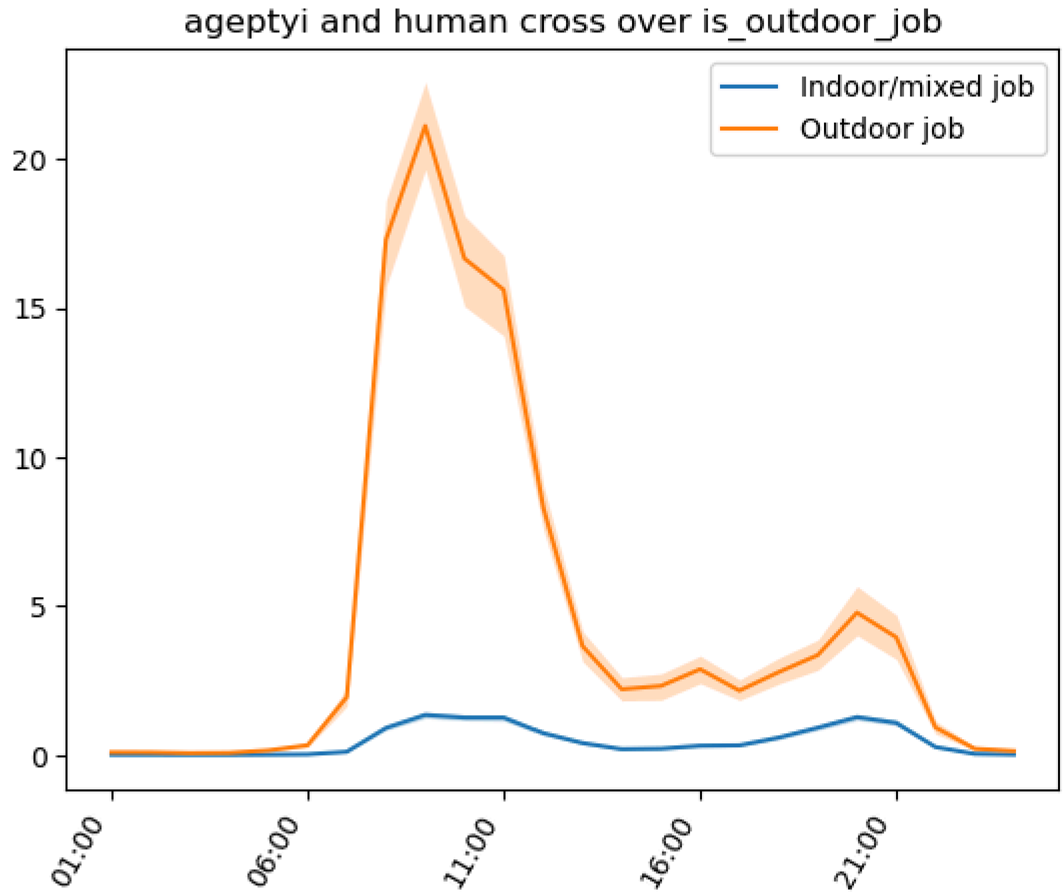
```
                       0
is_outdoor_job          
0               0.760418
1               7.515855
                       0
is_outdoor_job          
0               0.735804
1               7.181385
                       0
is_outdoor_job          
0               0.785977
1               7.844468
```

timeseries

In [74]:

```
mosq_human_df1=pd.concat(
    [boot_df_grp.xs(i,level=feat_name).mul(mosq_type_df) for i in lvls],
    axis=0,
    keys=lvls,
    names=[feat_name],
)

t_plot=mosq_human_df1/norm_6_pm_ageptyi

# for i in lvls:
i0=t_plot.xs(0,level=feat_name)
i1=t_plot.xs(1,level=feat_name)
# i2=t_plot.xs(2,level=feat_name)


fig, ax = plt.subplots()
```

```python
map_names=lvls.map(id_to_name)

# --- Generated uncertainty
ax.plot(i0.mean(axis=0), label=map_names[0], color="C0")
ax.plot(i1.mean(axis=0), label=map_names[1], color="C1")
# ax.plot(i2.mean(axis=0), label="mean i2", color="C2")
ax.fill_between(
    x=i0.columns,  # Hours
    y1=i0.quantile(q=0.025),  # Lower quantile
    y2=i0.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C0", linewidth=0,
)

ax.fill_between(
    x=i1.columns,  # Hours
    y1=i1.quantile(q=0.025),  # Lower quantile
    y2=i1.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C1", linewidth=0,
)

# ax.fill_between(
#     x=i2.columns,  # Hours
#     y1=i2.quantile(q=0.025),  # Lower quantile
#     y2=i2.quantile(q=0.975),  # Upper quantile
#     # Formatting options
#     alpha=0.25, color="C2", linewidth=0,
# )


rotate_ax_labels(ax)
ax.xaxis.set_major_formatter(mpl.dates.DateFormatter("%d:%H"))
plt.title(f"ageptyi and human cross over {feat_name}")

ax.legend()
plt.show()
if True:
    create_folder_if_not_exists('tmp_figs/preprint')
    fig.savefig(f"tmp_figs/preprint/ageptyi_{feat_name}_timeseries.pdf")
```



```
Folder 'tmp_figs/preprint' already exists.
```

In [75]:

```
all_df['feat']=all_df[feat_name]
all_df.drop(feat_name,inplace=True,axis=1)

multi_feat_df=pd.concat([multi_feat_df,all_df],ignore_index=True)
multi_feat_df
```

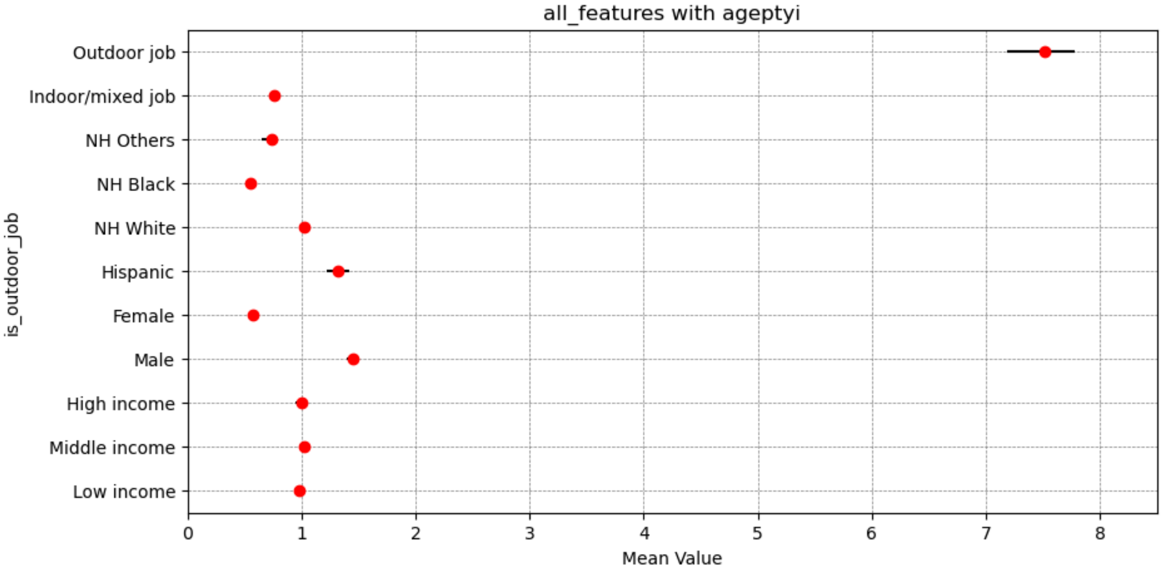
Out[75]:

	mean_val	lower	upper	feat
0	0.975768	0.044687	0.047678	Low income
1	1.019631	0.043386	0.047949	Middle income
2	1.003594	0.055596	0.051985	High income
3	1.451462	0.055195	0.044660	Male
4	0.578059	0.021574	0.017805	Female
5	1.318038	0.100722	0.103246	Hispanic
6	1.020166	0.037176	0.030502	NH White
7	0.552871	0.048407	0.038760	NH Black
8	0.732128	0.084968	0.052949	NH Others
9	0.760418	0.024613	0.016989	Indoor/mixed job
10	7.515855	0.334471	0.261881	Outdoor job

ageptyi multi features

```
In [83]: asymentric_err_bar=[multi_feat_df['lower'].values,multi_feat_df['upper'].values]


         fig,ax=plt.subplots(figsize=(10,5))

         ax.errorbar(y=multi_feat_df['feat'], x=multi_feat_df['mean_val'],xerr=asymentric

         ax.set_xlim(0, 8.5)

         ax.set_xlabel('Mean Value')
         ax.set_ylabel(feat_name)
         ax.set_title(f"all_features with ageptyi")
         # Customizing grid lines
         ax.grid(True, linestyle='--', color='gray', linewidth=0.5)



         create_folder_if_not_exists('tmp_figs/preprint')
         plt.savefig(f"tmp_figs/preprint/multi_features_with_ageptyi.pdf")
```

```
Folder 'tmp_figs/preprint' already exists.
```



```
In [ ]:
```

```
In [ ]:
```

with quinque

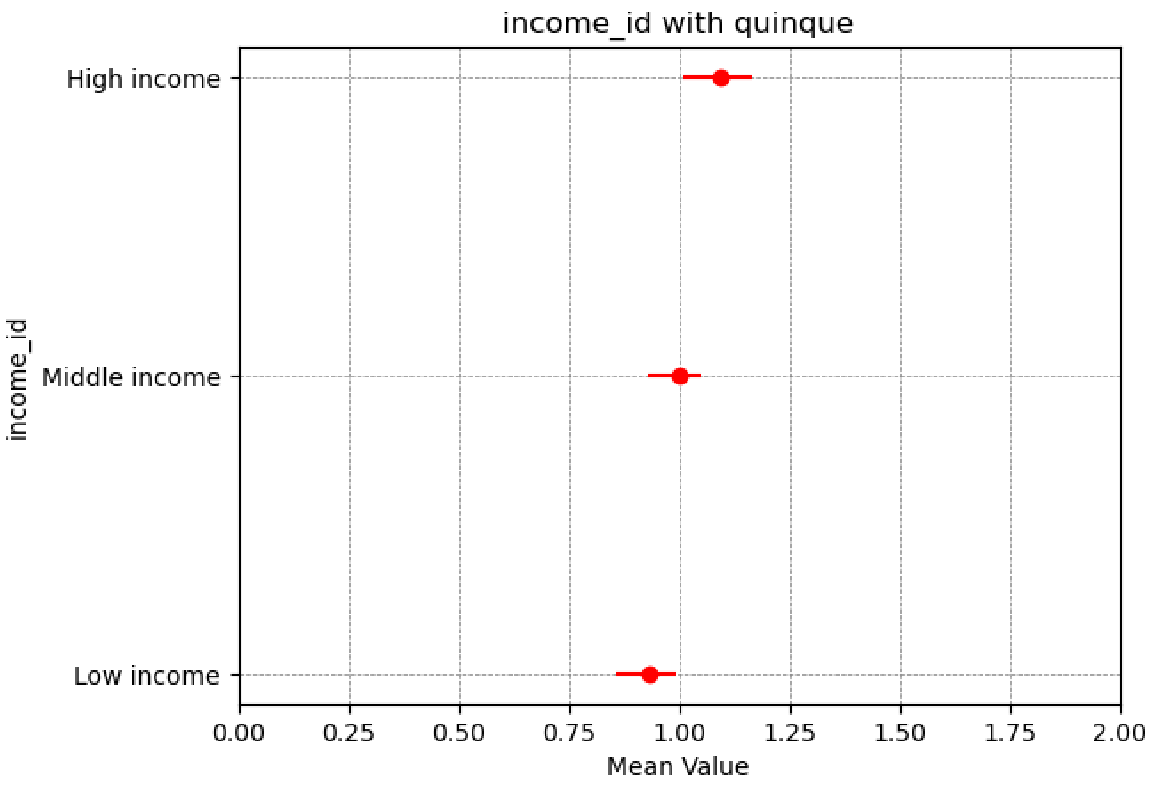
incomeID

```
In [92]: # ====================================
         # SELECTABLE FEATURE – Time series
         # ====================================
         exp_id = 1  # Outdoor only

         feat_name, id_to_name = "income_id", lambda x: env.income_id_to_name[x]
```

```
# feat_name, id_to_name = "PESEX", lambda x: env.pesex_to_name[x]
# feat_name, id_to_name = "race_ethnicity", lambda x: env.race_id_to_name[x]
# feat_name, id_to_name = "occupation_exposure_id", lambda x: f"{env.actype_id_t
# feat_name, id_to_name = "all", lambda x: "Everyone" if x else "No-one [:"
# feat_name, id_to_name = "is_outdoor_job", lambda x: "Outdoor job" if x else "I
# feat_name, id_to_name = "is_weekend", lambda x: "Weekends" if x else "Weekdays
# --- Composite features
# feat_name, id_to_name = "job_and_weekend", lambda x: f"{'outdoor' if x[0] else
# feat_name, id_to_name = "income_and_weekend", lambda x: f"{env.income_id_to_na
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x[0]==1 else
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x[0]==1 else
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x==1 else 'f
# feat_name, id_to_name = "raceth_and_weekend", lambda x: f"{env.race_id_to_name

main_df = main_pre.feat_aggr_df_dict[feat_name]
if hourly:
    main_df.columns.name = "hour"
else:
    main_df = att.aggregate_exp_minutes_to_hours(df)

main_df_wted = att.aggregate_states_series_with_weights(
    main_df, main_pre.slice_data_df["weight"],
#     use_level_values=["California", "Florida", "Texas"],
#     use_level_values=["Florida"],
)

boot_df = pd.concat(
    [boot_pre_list[i].feat_aggr_df_dict[feat_name] for i in samples],
    axis=0,
    keys=samples,
    names=["i_boot"],
)

if hourly:
    boot_df.columns.name = "hour"
else:
    boot_df = att.aggregate_exp_minutes_to_hours(df)

boot_df_wted = att.aggregate_states_series_with_weights(
    boot_df, main_pre.slice_data_df["weight"],
#     use_level_values=["California", "Florida", "Texas"],
#     use_level_values=["Florida"],
)


boot_df_grp=boot_df_wted.xs(exp_id, level="exp_id")
boot_df_grp.columns=hours
boot_df_grp.columns.name = "hour"

lvls=boot_df_grp.index.get_level_values(feat_name).unique()
mosq_type_df=df_rnd_mosq_quinque
mosq_human_df=pd.concat(
    [boot_df_grp.xs(i,level=feat_name).mul(mosq_type_df).sum(axis=1) for i in lv
    axis=0,
    keys=lvls,
    names=[feat_name],
).to_frame()

norm_quinque_human_df=mosq_human_df/mean_overall_human_pop_with_mosq_quinque
con_df=norm_quinque_human_df.groupby(feat_name).mean()
```

```
q_25=norm_quinque_human_df.groupby(feat_name).quantile(0.025)
q_95=norm_quinque_human_df.groupby(feat_name).quantile(0.925)

con_df['mean_val']=con_df[0]
q_25['q25']=q_25[0]
q_95['q95']=q_95[0]

con_df.drop(0,inplace=True,axis=1)
q_25.drop(0,inplace=True,axis=1)
q_95.drop(0,inplace=True,axis=1)

quantile=pd.merge(q_95,q_25,how='inner',on=feat_name)
# quantile['diff']=quantile['q95']-quantile['q25']

# quantile.drop(columns=['q25','q95'],inplace=True)

all_df=pd.merge(con_df,quantile,how='inner',on=feat_name)
all_df['lower']=all_df['mean_val']-all_df['q25']
all_df['upper']=all_df['q95']-all_df['mean_val']
all_df.drop(columns=['q25','q95'],inplace=True)
asymentric_err_bar=[all_df['lower'].values,all_df['upper'].values]


all_df=all_df.T

all_df.columns=all_df.columns.map(id_to_name)
all_df=all_df.T
all_df=all_df.reset_index()

fig,ax=plt.subplots()
ax.errorbar(y=all_df[feat_name], x=all_df['mean_val'],xerr=asymentric_err_bar, c

ax.set_xlim(0, 2)

ax.set_xlabel('Mean Value')
ax.set_ylabel(feat_name)
ax.set_title(f"{feat_name} with quinque")
# Customizing grid lines
ax.grid(True, linestyle='--', color='gray', linewidth=0.5)
fig.show()

create_folder_if_not_exists('tmp_figs/preprint')
plt.savefig(f"tmp_figs/preprint/fig3_{feat_name}_with_quinque.pdf")
```

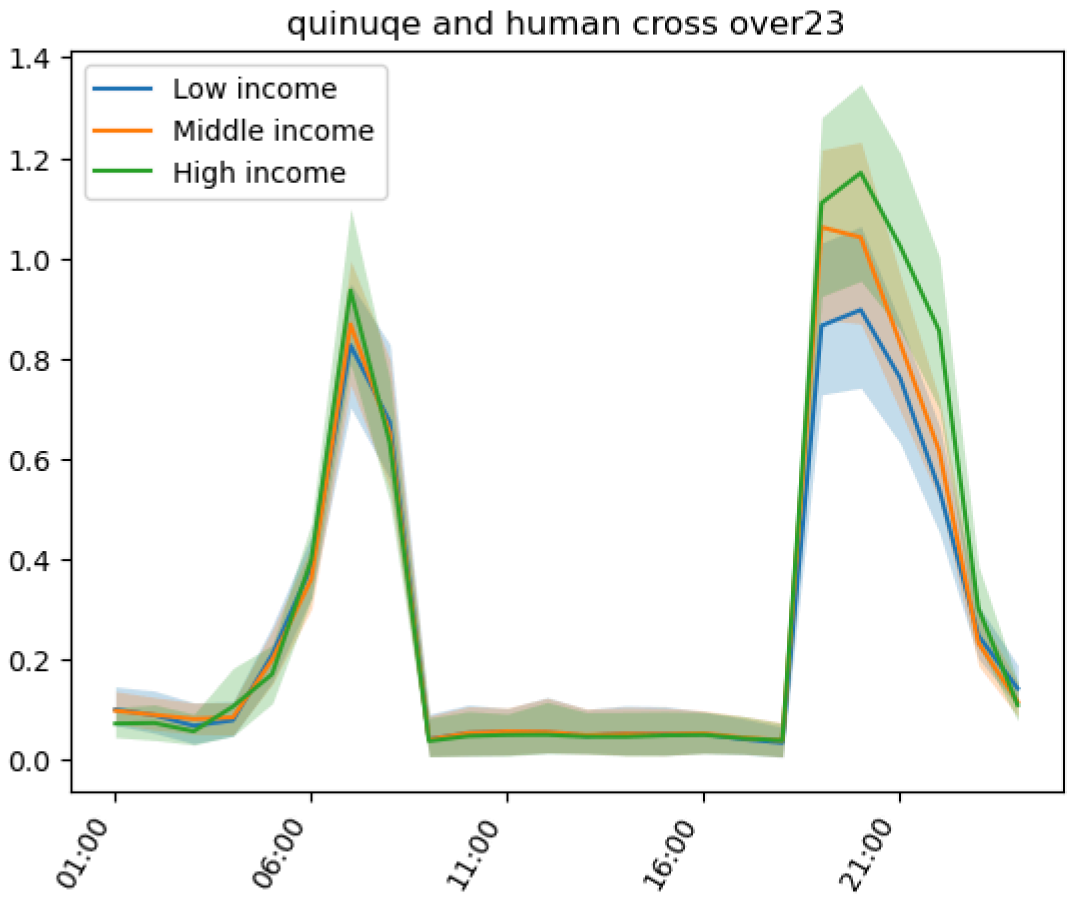
```
Folder 'tmp_figs/preprint' already exists.
```



timeseries

In [93]:

```
mosq_human_df1=pd.concat(
    [boot_df_grp.xs(i,level=feat_name).mul(mosq_type_df) for i in lvls],
    axis=0,
    keys=lvls,
    names=[feat_name],
)
t_plot=mosq_human_df1/norm_6_pm_quinque

# for i in lvls:
i0=t_plot.xs(0,level=feat_name)
i1=t_plot.xs(1,level=feat_name)
i2=t_plot.xs(2,level=feat_name)


fig, ax = plt.subplots()

map_names=lvls.map(id_to_name)
# --- Generated uncertainty
ax.plot(i0.mean(axis=0), label=map_names[0], color="C0")
ax.plot(i1.mean(axis=0), label=map_names[1], color="C1")
ax.plot(i2.mean(axis=0), label= map_names[2], color="C2")
ax.fill_between(
    x=i0.columns,  # Hours
    y1=i0.quantile(q=0.025),  # Lower quantile
    y2=i0.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C0", linewidth=0,
)

ax.fill_between(
    x=i1.columns,  # Hours
    y1=i1.quantile(q=0.025),  # Lower quantile
    y2=i1.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C1", linewidth=0,
)

ax.fill_between(
    x=i2.columns,  # Hours
    y1=i2.quantile(q=0.025),  # Lower quantile
    y2=i2.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C2", linewidth=0,
)


rotate_ax_labels(ax)
ax.xaxis.set_major_formatter(mpl.dates.DateFormatter("%d:%H"))
plt.title(f"quinuqe and human cross over{i}")

ax.legend()
plt.show()
if True:
    create_folder_if_not_exists('tmp_figs/preprint')
    fig.savefig(f"tmp_figs/preprint/quinque_{feat_name}_timeseries.pdf")
```



```
Folder 'tmp_figs/preprint' already exists.
```

In [94]:

```
all_df['feat']=all_df[feat_name]
all_df.drop(feat_name,inplace=True,axis=1)
all_df

multi_feat_df_quinque=all_df.copy()
multi_feat_df_quinque
```

Out[94]:

	mean_val	lower	upper	feat
0	0.933387	0.076457	0.060683	Low income
1	1.000632	0.072274	0.048337	Middle income
2	1.095177	0.085334	0.072183	High income

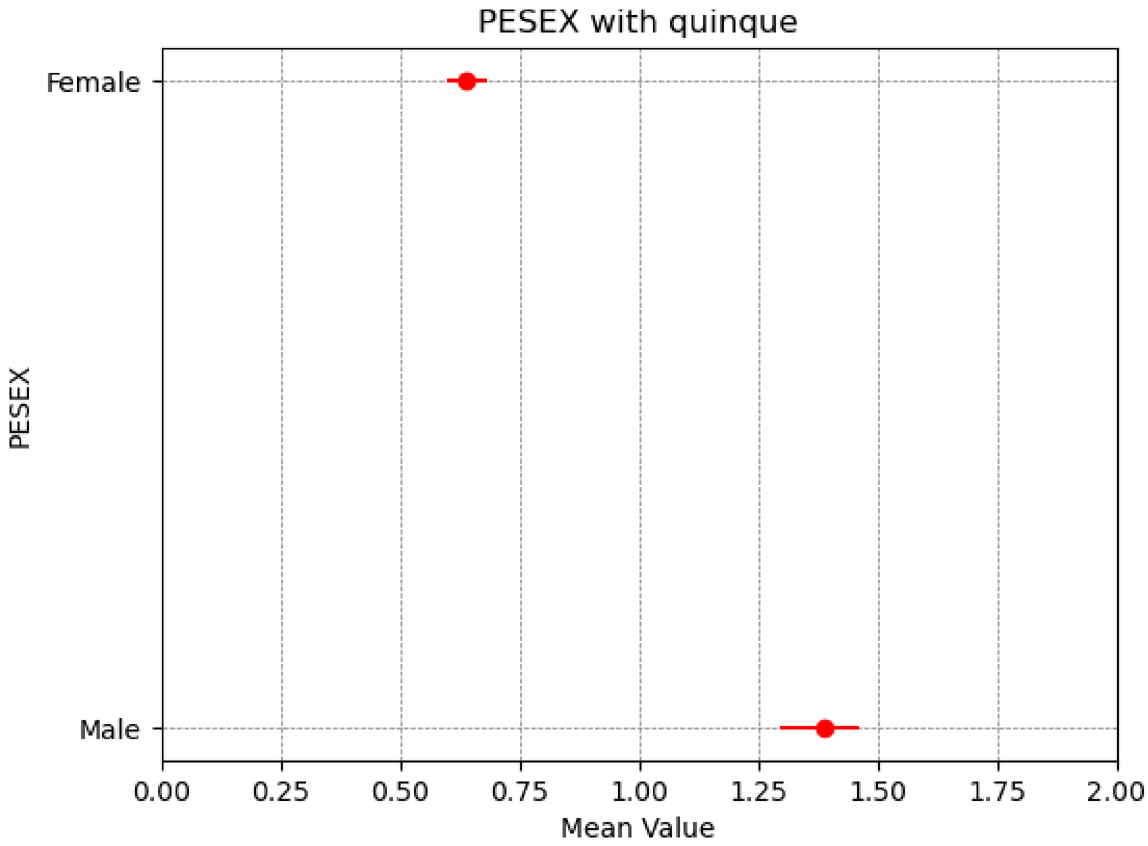
Gender

In [95]:

```
# ====================================
# SELECTABLE FEATURE - Time series
# ====================================
exp_id = 1  # Outdoor only

# feat_name, id_to_name = "income_id", lambda x: env.income_id_to_name[x]
feat_name, id_to_name = "PESEX", lambda x: env.pesex_to_name[x]
# feat_name, id_to_name = "race_ethnicity", lambda x: env.race_id_to_name[x]
# feat_name, id_to_name = "occupation_exposure_id", lambda x: f"{env.actype_id_t
# feat_name, id_to_name = "all", lambda x: "Everyone" if x else "No-one [:"
# feat_name, id_to_name = "is_outdoor_job", lambda x: "Outdoor job" if x else "I
# feat_name, id_to_name = "is_weekend", lambda x: "Weekends" if x else "Weekdays
# --- Composite features
# feat_name, id_to_name = "job_and_weekend", lambda x: f"{'outdoor' if x[0] else
# feat_name, id_to_name = "income_and_weekend", lambda x: f"{env.income_id_to_na
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x[0]==1 else
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x[0]==1 else
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x==1 else 'f
# feat_name, id_to_name = "raceth_and_weekend", lambda x: f"{env.race_id_to_name

main_df = main_pre.feat_aggr_df_dict[feat_name]
if hourly:
    main_df.columns.name = "hour"
else:
    main_df = att.aggregate_exp_minutes_to_hours(df)

main_df_wted = att.aggregate_states_series_with_weights(
    main_df, main_pre.slice_data_df["weight"],
#     use_level_values=["California", "Florida", "Texas"],
#     use_level_values=["Florida"],
)

boot_df = pd.concat(
    [boot_pre_list[i].feat_aggr_df_dict[feat_name] for i in samples],
    axis=0,
    keys=samples,
    names=["i_boot"],
)

if hourly:
    boot_df.columns.name = "hour"
else:
    boot_df = att.aggregate_exp_minutes_to_hours(df)

boot_df_wted = att.aggregate_states_series_with_weights(
    boot_df, main_pre.slice_data_df["weight"],
#     use_level_values=["California", "Florida", "Texas"],
#     use_level_values=["Florida"],
)


boot_df_grp=boot_df_wted.xs(exp_id, level="exp_id")
boot_df_grp.columns=hours
boot_df_grp.columns.name = "hour"

lvls=boot_df_grp.index.get_level_values(feat_name).unique()
mosq_type_df=df_rnd_mosq_quinque
mosq_human_df=pd.concat(
    [boot_df_grp.xs(i,level=feat_name).mul(mosq_type_df).sum(axis=1) for i in lv
    axis=0,
    keys=lvls,
    names=[feat_name],
).to_frame()

norm_quinque_human_df=mosq_human_df/mean_overall_human_pop_with_mosq_quinque
con_df=norm_quinque_human_df.groupby(feat_name).mean()
q_25=norm_quinque_human_df.groupby(feat_name).quantile(0.025)
q_95=norm_quinque_human_df.groupby(feat_name).quantile(0.925)

con_df['mean_val']=con_df[0]
q_25['q25']=q_25[0]
q_95['q95']=q_95[0]

con_df.drop(0,inplace=True,axis=1)
q_25.drop(0,inplace=True,axis=1)
q_95.drop(0,inplace=True,axis=1)

quantile=pd.merge(q_95,q_25,how='inner',on=feat_name)
# quantile['diff']=quantile['q95']-quantile['q25']

# quantile.drop(columns=['q25','q95'],inplace=True)

all_df=pd.merge(con_df,quantile,how='inner',on=feat_name)
all_df['lower']=all_df['mean_val']-all_df['q25']
all_df['upper']=all_df['q95']-all_df['mean_val']
all_df.drop(columns=['q25','q95'],inplace=True)
asymentric_err_bar=[all_df['lower'].values,all_df['upper'].values]


all_df=all_df.T

all_df.columns=all_df.columns.map(id_to_name)
all_df=all_df.T
all_df=all_df.reset_index()

fig,ax=plt.subplots()
ax.errorbar(y=all_df[feat_name], x=all_df['mean_val'],xerr=asymentric_err_bar, c

ax.set_xlim(0, 2)

ax.set_xlabel('Mean Value')
ax.set_ylabel(feat_name)
ax.set_title(f"{feat_name} with quinque")
# Customizing grid lines
ax.grid(True, linestyle='--', color='gray', linewidth=0.5)
fig.show()
```

```
create_folder_if_not_exists('tmp_figs/preprint')
plt.savefig(f"tmp_figs/preprint/fig3_{feat_name}_with_quinque.pdf")
```

```
Folder 'tmp_figs/preprint' already exists.
```



In [96]:

```
print(norm_quinque_human_df.groupby(feat_name).mean())
print(norm_quinque_human_df.groupby(feat_name).quantile(q=0.025))
print(norm_quinque_human_df.groupby(feat_name).quantile(q=0.975))
```

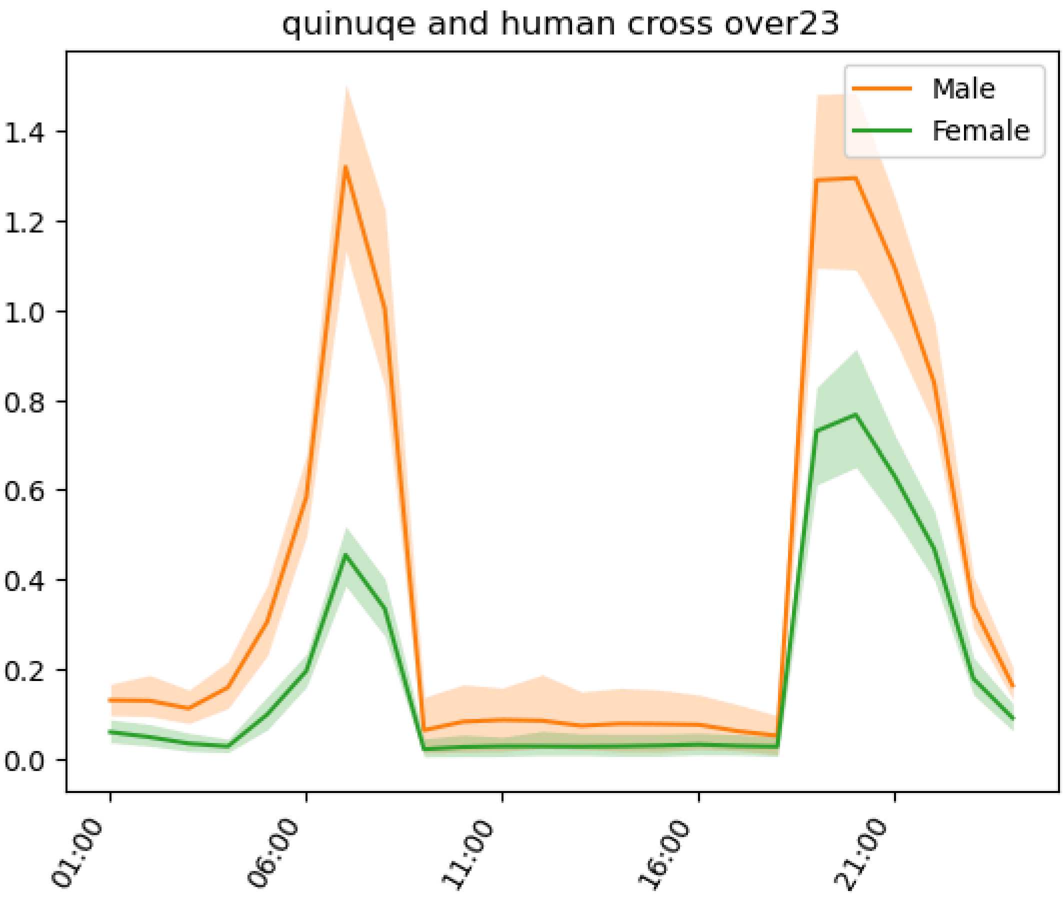
```
              0
PESEX
1      1.387253
2      0.639979
              0
PESEX
1      1.295329
2      0.596812
              0
PESEX
1      1.484680
2      0.694078
```

timeserires

In [97]:

```
mosq_human_df1=pd.concat(
    [boot_df_grp.xs(i,level=feat_name).mul(mosq_type_df) for i in lvls],
    axis=0,
    keys=lvls,
    names=[feat_name],
)
t_plot=mosq_human_df1/norm_6_pm_quinque

# for i in lvls:
# i0=t_plot.xs(0,level=feat_name)
```

```
i1=t_plot.xs(1,level=feat_name)
i2=t_plot.xs(2,level=feat_name)


fig, ax = plt.subplots()

map_names=lvls.map(id_to_name)
# --- Generated uncertainty
# ax.plot(i0.mean(axis=0), label=map_names[0], color="C0")
ax.plot(i1.mean(axis=0), label=map_names[0], color="C1")
ax.plot(i2.mean(axis=0), label= map_names[1], color="C2")
# ax.fill_between(
#     x=i0.columns,  # Hours
#     y1=i0.quantile(q=0.025),  # Lower quantile
#     y2=i0.quantile(q=0.975),  # Upper quantile
#     # Formatting options
#     alpha=0.25, color="C0", linewidth=0,
# )

ax.fill_between(
    x=i1.columns,  # Hours
    y1=i1.quantile(q=0.025),  # Lower quantile
    y2=i1.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C1", linewidth=0,
)

ax.fill_between(
    x=i2.columns,  # Hours
    y1=i2.quantile(q=0.025),  # Lower quantile
    y2=i2.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C2", linewidth=0,
)


rotate_ax_labels(ax)
ax.xaxis.set_major_formatter(mpl.dates.DateFormatter("%d:%H"))
plt.title(f"quinuqe and human cross over{i}")

ax.legend()
plt.show()
if True:
    create_folder_if_not_exists('tmp_figs/preprint')
    fig.savefig(f"tmp_figs/preprint/quinque_{feat_name}_timeseries.pdf")
```



```
Folder 'tmp_figs/preprint' already exists.
```

In [98]:

```
all_df['feat']=all_df[feat_name]
all_df.drop(feat_name,inplace=True,axis=1)

multi_feat_df_quinque=pd.concat([multi_feat_df_quinque,all_df],ignore_index=True
multi_feat_df_quinque
```

Out[98]:

	mean_val	lower	upper	feat
0	0.933387	0.076457	0.060683	Low income
1	1.000632	0.072274	0.048337	Middle income
2	1.095177	0.085334	0.072183	High income
3	1.387253	0.091923	0.074613	Male
4	0.639979	0.043167	0.043183	Female

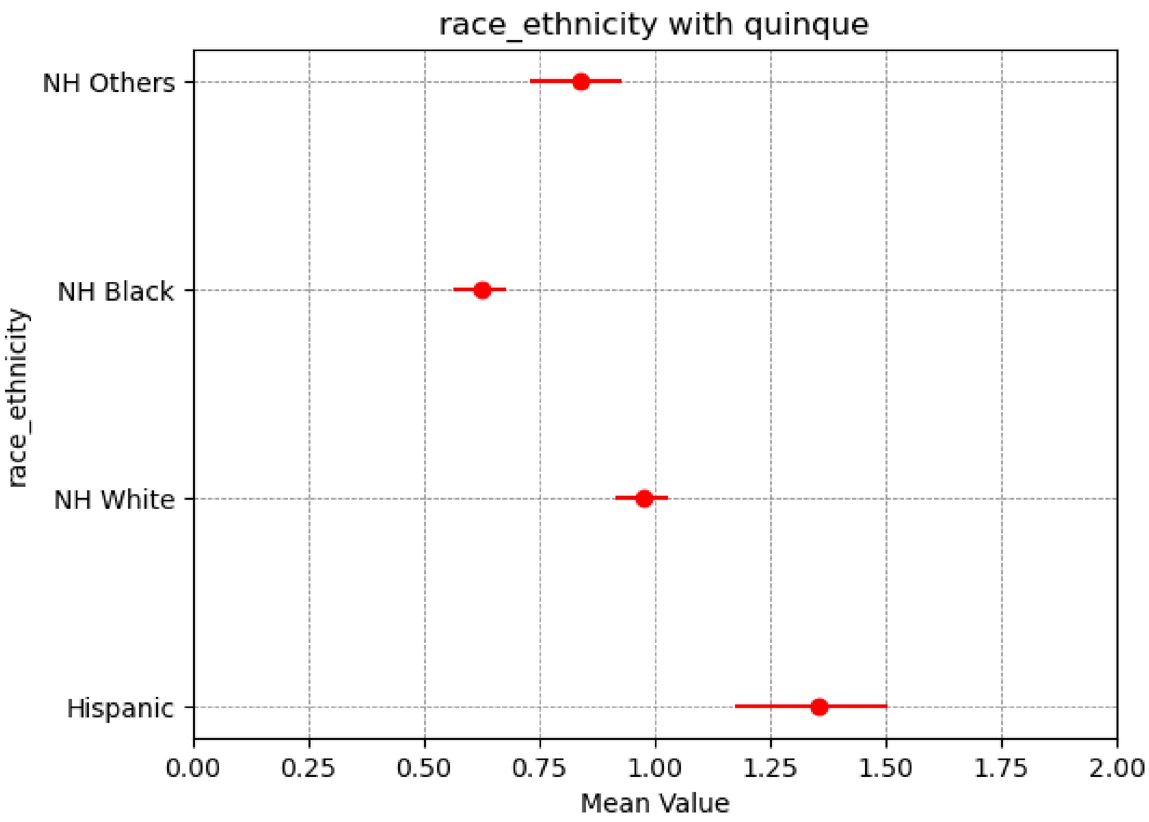
Race and ethnicity

In [99]:

```
# ====================================
# SELECTABLE FEATURE - Time series
# ====================================
exp_id = 1  # Outdoor only

# feat_name, id_to_name = "income_id", lambda x: env.income_id_to_name[x]
# feat_name, id_to_name = "PESEX", lambda x: env.pesex_to_name[x]
feat_name, id_to_name = "race_ethnicity", lambda x: env.race_id_to_name[x]
# feat_name, id_to_name = "occupation_exposure_id", lambda x: f"{env.actype_id_t
# feat_name, id_to_name = "all", lambda x: "Everyone" if x else "No-one [:"
# feat_name, id_to_name = "is_outdoor_job", lambda x: "Outdoor job" if x else "I
# feat_name, id_to_name = "is_weekend", lambda x: "Weekends" if x else "Weekdays
# --- Composite features
# feat_name, id_to_name = "job_and_weekend", lambda x: f"{'outdoor' if x[0] else
# feat_name, id_to_name = "income_and_weekend", lambda x: f"{env.income_id_to_na
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x[0]==1 else
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x[0]==1 else
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x==1 else 'f
# feat_name, id_to_name = "raceth_and_weekend", lambda x: f"{env.race_id_to_name

main_df = main_pre.feat_aggr_df_dict[feat_name]
if hourly:
    main_df.columns.name = "hour"
else:
    main_df = att.aggregate_exp_minutes_to_hours(df)

main_df_wted = att.aggregate_states_series_with_weights(
    main_df, main_pre.slice_data_df["weight"],
#     use_level_values=["California", "Florida", "Texas"],
#     use_level_values=["Florida"],
)

boot_df = pd.concat(
    [boot_pre_list[i].feat_aggr_df_dict[feat_name] for i in samples],
    axis=0,
    keys=samples,
    names=["i_boot"],
)

if hourly:
    boot_df.columns.name = "hour"
else:
    boot_df = att.aggregate_exp_minutes_to_hours(df)

boot_df_wted = att.aggregate_states_series_with_weights(
    boot_df, main_pre.slice_data_df["weight"],
#     use_level_values=["California", "Florida", "Texas"],
#     use_level_values=["Florida"],
)


boot_df_grp=boot_df_wted.xs(exp_id, level="exp_id")
boot_df_grp.columns=hours
boot_df_grp.columns.name = "hour"

lvls=boot_df_grp.index.get_level_values(feat_name).unique()
mosq_type_df=df_rnd_mosq_quinque
mosq_human_df=pd.concat(
    [boot_df_grp.xs(i,level=feat_name).mul(mosq_type_df).sum(axis=1) for i in lv
    axis=0,
    keys=lvls,
    names=[feat_name],
).to_frame()

norm_quinque_human_df=mosq_human_df/mean_overall_human_pop_with_mosq_quinque
con_df=norm_quinque_human_df.groupby(feat_name).mean()
q_25=norm_quinque_human_df.groupby(feat_name).quantile(0.025)
q_95=norm_quinque_human_df.groupby(feat_name).quantile(0.925)

con_df['mean_val']=con_df[0]
```

```python
q_25['q25']=q_25[0]
q_95['q95']=q_95[0]

con_df.drop(0,inplace=True,axis=1)
q_25.drop(0,inplace=True,axis=1)
q_95.drop(0,inplace=True,axis=1)

quantile=pd.merge(q_95,q_25,how='inner',on=feat_name)
# quantile['diff']=quantile['q95']-quantile['q25']

# quantile.drop(columns=['q25','q95'],inplace=True)

all_df=pd.merge(con_df,quantile,how='inner',on=feat_name)
all_df['lower']=all_df['mean_val']-all_df['q25']
all_df['upper']=all_df['q95']-all_df['mean_val']
all_df.drop(columns=['q25','q95'],inplace=True)
asymentric_err_bar=[all_df['lower'].values,all_df['upper'].values]


all_df=all_df.T

all_df.columns=all_df.columns.map(id_to_name)
all_df=all_df.T
all_df=all_df.reset_index()

fig,ax=plt.subplots()
ax.errorbar(y=all_df[feat_name], x=all_df['mean_val'],xerr=asymentric_err_bar, c

ax.set_xlim(0, 2)

ax.set_xlabel('Mean Value')
ax.set_ylabel(feat_name)
ax.set_title(f"{feat_name} with quinque")
# Customizing grid lines
ax.grid(True, linestyle='--', color='gray', linewidth=0.5)
fig.show()

create_folder_if_not_exists('tmp_figs/preprint')
plt.savefig(f"tmp_figs/preprint/fig3_{feat_name}_with_quinque.pdf")
```

```
Folder 'tmp_figs/preprint' already exists.
```



In [100…

```
print(norm_quinque_human_df.groupby(feat_name).mean())
print(norm_quinque_human_df.groupby(feat_name).quantile(q=0.025))
print(norm_quinque_human_df.groupby(feat_name).quantile(q=0.975))
```

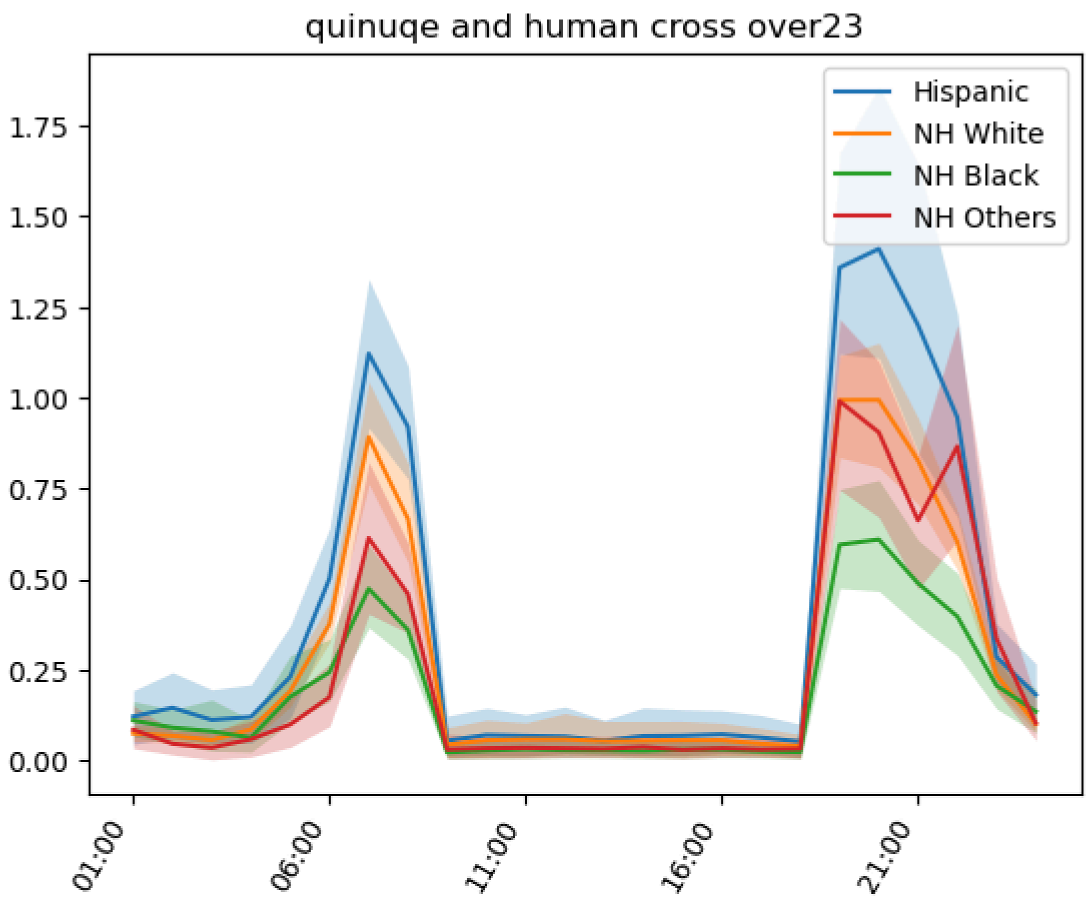
```
                       0
race_ethnicity          
0               1.355322
1               0.974610
2               0.626453
3               0.839486
                       0
race_ethnicity          
0               1.171266
1               0.915995
2               0.564840
3               0.729303
                       0
race_ethnicity          
0               1.558593
1               1.037228
2               0.706915
3               0.948402
```

timeseries

In [101…

```
mosq_human_df1=pd.concat(
    [boot_df_grp.xs(i,level=feat_name).mul(mosq_type_df) for i in lvls],
    axis=0,
    keys=lvls,
    names=[feat_name],
)
t_plot=mosq_human_df1/norm_6_pm_quinque

# for i in lvls:
```

```python
i0=t_plot.xs(0,level=feat_name)
i1=t_plot.xs(1,level=feat_name)
i2=t_plot.xs(2,level=feat_name)
i3=t_plot.xs(3,level=feat_name)

fig, ax = plt.subplots()

map_names=lvls.map(id_to_name)
# --- Generated uncertainty
ax.plot(i0.mean(axis=0), label=map_names[0], color="C0")
ax.plot(i1.mean(axis=0), label=map_names[1], color="C1")
ax.plot(i2.mean(axis=0), label= map_names[2], color="C2")
ax.plot(i3.mean(axis=0), label= map_names[3], color="C3")
ax.fill_between(
    x=i0.columns,  # Hours
    y1=i0.quantile(q=0.025),  # Lower quantile
    y2=i0.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C0", linewidth=0,
)

ax.fill_between(
    x=i1.columns,  # Hours
    y1=i1.quantile(q=0.025),  # Lower quantile
    y2=i1.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C1", linewidth=0,
)

ax.fill_between(
    x=i2.columns,  # Hours
    y1=i2.quantile(q=0.025),  # Lower quantile
    y2=i2.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C2", linewidth=0,
)

ax.fill_between(
    x=i3.columns,  # Hours
    y1=i3.quantile(q=0.025),  # Lower quantile
    y2=i3.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C3", linewidth=0,
)

rotate_ax_labels(ax)
ax.xaxis.set_major_formatter(mpl.dates.DateFormatter("%d:%H"))
plt.title(f"quinuqe and human cross over{i}")

ax.legend()
plt.show()
if True:
    create_folder_if_not_exists('tmp_figs/preprint')
    fig.savefig(f"tmp_figs/preprint/quinque_{feat_name}_timeseries.pdf")
```



```
Folder 'tmp_figs/preprint' already exists.
```

In [102…

```
all_df['feat']=all_df[feat_name]
all_df.drop(feat_name,inplace=True,axis=1)

multi_feat_df_quinque=pd.concat([multi_feat_df_quinque,all_df],ignore_index=True
multi_feat_df_quinque
```

Out[102…

	mean_val	lower	upper	feat
0	0.933387	0.076457	0.060683	Low income
1	1.000632	0.072274	0.048337	Middle income
2	1.095177	0.085334	0.072183	High income
3	1.387253	0.091923	0.074613	Male
4	0.639979	0.043167	0.043183	Female
5	1.355322	0.184056	0.146935	Hispanic
6	0.974610	0.058615	0.052484	NH White
7	0.626453	0.061613	0.050900	NH Black
8	0.839486	0.110183	0.088742	NH Others

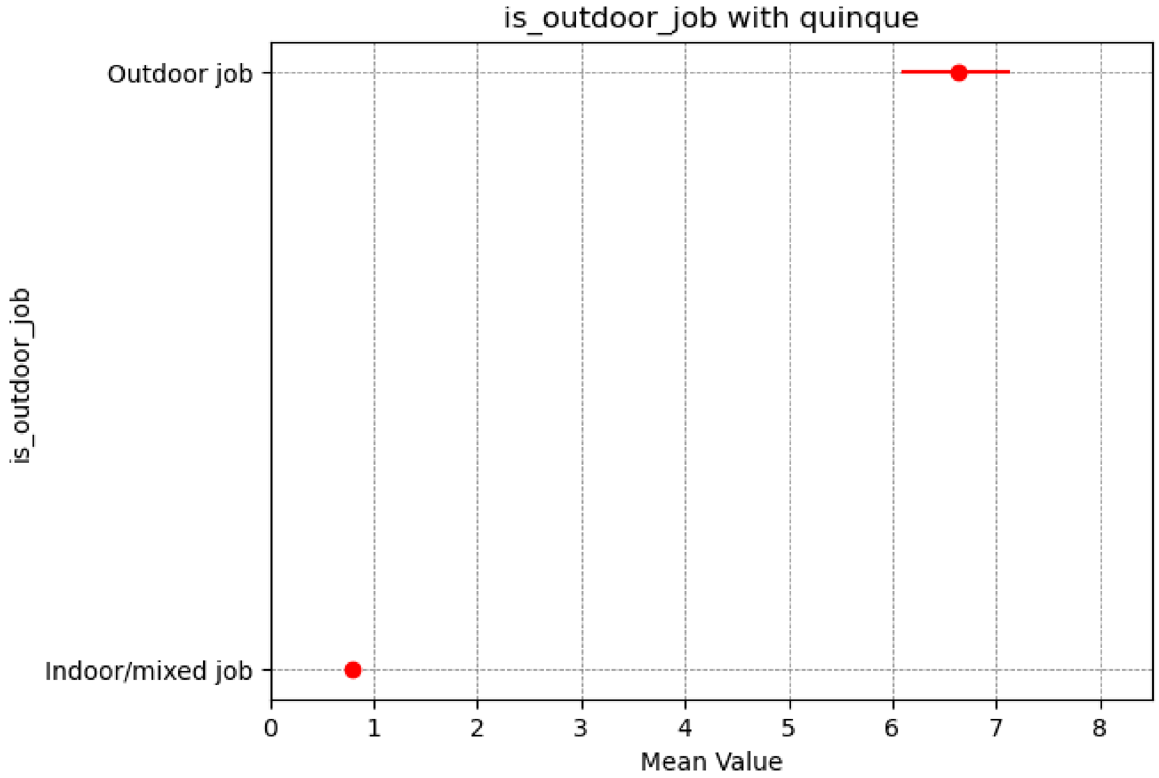
is_outdoor_job

In [103…

```
# ====================================
# SELECTABLE FEATURE - Time series
# ====================================
exp_id = 1  # Outdoor only

# feat_name, id_to_name = "income_id", lambda x: env.income_id_to_name[x]
# feat_name, id_to_name = "PESEX", lambda x: env.pesex_to_name[x]
# feat_name, id_to_name = "race_ethnicity", lambda x: env.race_id_to_name[x]
# feat_name, id_to_name = "occupation_exposure_id", lambda x: f"{env.actype_id_t
# feat_name, id_to_name = "all", lambda x: "Everyone" if x else "No-one [:"
feat_name, id_to_name = "is_outdoor_job", lambda x: "Outdoor job" if x else "Ind
# feat_name, id_to_name = "is_weekend", lambda x: "Weekends" if x else "Weekdays
# --- Composite features
# feat_name, id_to_name = "job_and_weekend", lambda x: f"{'outdoor' if x[0] else
# feat_name, id_to_name = "income_and_weekend", lambda x: f"{env.income_id_to_na
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x[0]==1 else
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x[0]==1 else
# feat_name, id_to_name = "sex_and_weekend", lambda x: f"{'male' if x==1 else 'f
# feat_name, id_to_name = "raceth_and_weekend", lambda x: f"{env.race_id_to_name

main_df = main_pre.feat_aggr_df_dict[feat_name]
if hourly:
    main_df.columns.name = "hour"
else:
    main_df = att.aggregate_exp_minutes_to_hours(df)

main_df_wted = att.aggregate_states_series_with_weights(
    main_df, main_pre.slice_data_df["weight"],
#     use_level_values=["California", "Florida", "Texas"],
#     use_level_values=["Florida"],
)

boot_df = pd.concat(
    [boot_pre_list[i].feat_aggr_df_dict[feat_name] for i in samples],
    axis=0,
    keys=samples,
    names=["i_boot"],
)

if hourly:
    boot_df.columns.name = "hour"
else:
    boot_df = att.aggregate_exp_minutes_to_hours(df)

boot_df_wted = att.aggregate_states_series_with_weights(
    boot_df, main_pre.slice_data_df["weight"],
#     use_level_values=["California", "Florida", "Texas"],
#     use_level_values=["Florida"],
)


boot_df_grp=boot_df_wted.xs(exp_id, level="exp_id")
boot_df_grp.columns=hours
boot_df_grp.columns.name = "hour"

lvls=boot_df_grp.index.get_level_values(feat_name).unique()
mosq_type_df=df_rnd_mosq_quinque
mosq_human_df=pd.concat(
    [boot_df_grp.xs(i,level=feat_name).mul(mosq_type_df).sum(axis=1) for i in lv
    axis=0,
    keys=lvls,
    names=[feat_name],
).to_frame()
```

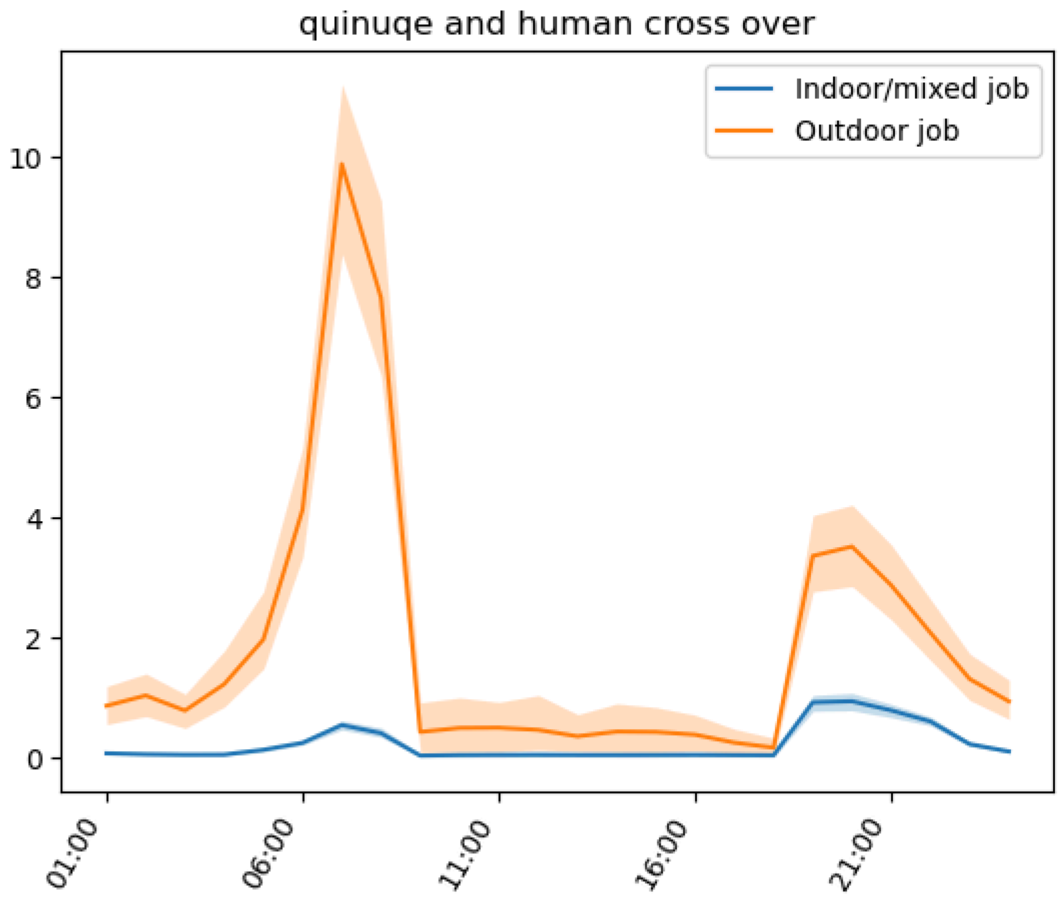
```
norm_quinque_human_df=mosq_human_df/mean_overall_human_pop_with_mosq_quinque
con_df=norm_quinque_human_df.groupby(feat_name).mean()
q_25=norm_quinque_human_df.groupby(feat_name).quantile(0.025)
q_95=norm_quinque_human_df.groupby(feat_name).quantile(0.925)

con_df['mean_val']=con_df[0]
q_25['q25']=q_25[0]
q_95['q95']=q_95[0]

con_df.drop(0,inplace=True,axis=1)
q_25.drop(0,inplace=True,axis=1)
q_95.drop(0,inplace=True,axis=1)

quantile=pd.merge(q_95,q_25,how='inner',on=feat_name)
# quantile['diff']=quantile['q95']-quantile['q25']

# quantile.drop(columns=['q25','q95'],inplace=True)

all_df=pd.merge(con_df,quantile,how='inner',on=feat_name)
all_df['lower']=all_df['mean_val']-all_df['q25']
all_df['upper']=all_df['q95']-all_df['mean_val']
all_df.drop(columns=['q25','q95'],inplace=True)
asymentric_err_bar=[all_df['lower'].values,all_df['upper'].values]


all_df=all_df.T

all_df.columns=all_df.columns.map(id_to_name)
all_df=all_df.T
all_df=all_df.reset_index()

fig,ax=plt.subplots()
ax.errorbar(y=all_df[feat_name], x=all_df['mean_val'],xerr=asymentric_err_bar, c

ax.set_xlim(0, 8.5)

ax.set_xlabel('Mean Value')
ax.set_ylabel(feat_name)
ax.set_title(f"{feat_name} with quinque")
# Customizing grid lines
ax.grid(True, linestyle='--', color='gray', linewidth=0.5)
fig.show()

create_folder_if_not_exists('tmp_figs/preprint')
plt.savefig(f"tmp_figs/preprint/fig3_{feat_name}_with_quinque.pdf")
```

```
Folder 'tmp_figs/preprint' already exists.
```



timeseries

```
In [105…
mosq_human_df1=pd.concat(
    [boot_df_grp.xs(i,level=feat_name).mul(mosq_type_df) for i in lvls],
    axis=0,
    keys=lvls,
    names=[feat_name],
)
t_plot=mosq_human_df1/norm_6_pm_quinque

# for i in lvls:
i0=t_plot.xs(0,level=feat_name)
i1=t_plot.xs(1,level=feat_name)
# i2=t_plot.xs(2,level=feat_name)


fig, ax = plt.subplots()

map_names=lvls.map(id_to_name)
# --- Generated uncertainty
ax.plot(i0.mean(axis=0), label=map_names[0], color="C0")
ax.plot(i1.mean(axis=0), label=map_names[1], color="C1")
# ax.plot(i2.mean(axis=0), label= map_names[2], color="C2")
ax.fill_between(
    x=i0.columns,  # Hours
    y1=i0.quantile(q=0.025),  # Lower quantile
    y2=i0.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C0", linewidth=0,
)

ax.fill_between(
    x=i1.columns,  # Hours
    y1=i1.quantile(q=0.025),  # Lower quantile
    y2=i1.quantile(q=0.975),  # Upper quantile
    # Formatting options
    alpha=0.25, color="C1", linewidth=0,
)

# ax.fill_between(
#     x=i2.columns,  # Hours
#     y1=i2.quantile(q=0.025),  # Lower quantile
#     y2=i2.quantile(q=0.975),  # Upper quantile
#     # Formatting options
#     alpha=0.25, color="C2", linewidth=0,
# )


rotate_ax_labels(ax)
ax.xaxis.set_major_formatter(mpl.dates.DateFormatter("%d:%H"))
plt.title(f"quinuqe and human cross over")

ax.legend()
plt.show()
if True:
    create_folder_if_not_exists('tmp_figs/preprint')
    fig.savefig(f"tmp_figs/preprint/quinque_{feat_name}_timeseries.pdf")
```



```
Folder 'tmp_figs/preprint' already exists.
```